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BIRD-BANDING

A JOURNAL OF ORNITHOLOGICAL INVESTIGATION

VOL. XXXII JULY, 1961 No. 3

THE USE OF A HELIGOLAND TRAP AND MIST-NETS AT LONG POINT, ONTARIO[1]

By D. J. T. HUSSELL and JAMES WOODFORD

INTRODUCTION

Although Heligoland traps are in extensive use at Bird Observatories and elsewhere in Europe, very little use has been made of them in North America. As far as the writers are aware the only full size Heligoland trap constructed in North America before 1960 was the one at Point Pelee, Ontario (Gunn, 1954; Woodford and Wasserfall, 1958). The design, construction, and operation of Heligoland traps have been described in detail in many European publications (see Woodford and Hussell (1961) for a list of references) and the advantages and disadvantages of Heligoland traps versus mist-nets have been discussed by Williamson (1957) based on experiences at Fair Isle, and by Woodford (1959) at Point Pelee.

During the spring of 1960 a Heligoland trap was built by members of the Ontario Bird Banding Association at Long Point, Ontario. Since the dismantling of the Point Pelee trap, it is believed that this is the only Heligoland trap in use in North America, and the additional experience gained may be of some interest to banders operating co-operative stations similar to that at Long Point.

LOCATION

Long Point consists of a sandy bar jutting out for about twenty miles into Lake Erie. It lies approximately on an East-West line, while the northern shore of Lake Erie, although somewhat irregular, runs predominantly E.N.E.—W.S.W. Much of the point is wooded, and there are large expanses of marshland, but the extreme eastern end where the trap is situated is an area of dunes with a thin cover of poplars and willow generally not more than 30 feet in height. Long, narrow marshes lie between the dunes, which tend to form long ridges in a S.W.—N.E. direction.

The end of the Point is very exposed, being situated near the middle of Lake Erie, and strong winds occur frequently.

DESCRIPTION OF THE TRAP

Photographs of the trap are shown in Figures 1 and 2. The design of the trap follows the general plan described by Brownlow (1952). It consists of a wooden framework covered with wire-netting (½″ mesh, except the main roof section which is 1″ mesh). Much of the framework was built from driftwood, which considerably reduced the cost.

[1]A publication of the Long Point Bird Observatory, of the Ontario Bird Banding Association.

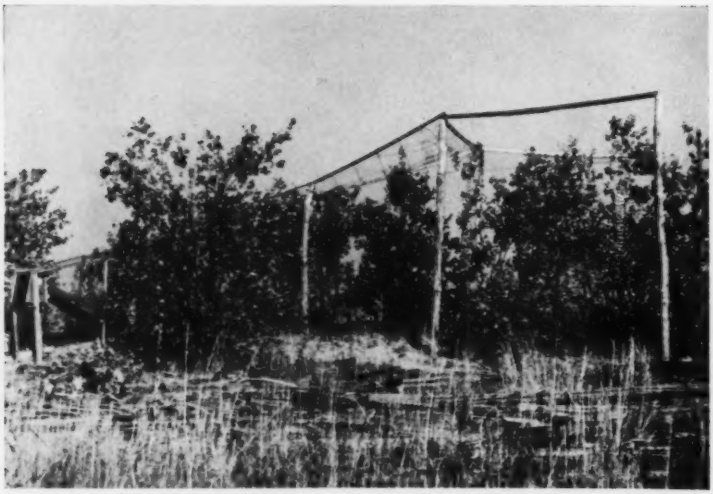

Figure 1. The Heligoland Trap at Long Point, Ontario—side view.

Figure 2. Removing a bird from the catching-box. Note wire-netting funnel and wooden ramp leading to entrance of catching-box.

The entrance of the trap is approximately 16 ft. wide by 14½ ft. high with wing walls of the same height about 15 ft. and 20 ft. long. The roofed section of the funnel narrows down to a cross-section of about 3½ ft. wide by 6 ft. high in a distance of 24 ft., and turns through an angle of about 50°. A baffle 18 inches in width has been constructed at the entrance of the trap, and another 10 inches in width at the 3½ x 6 ft. section. The funnel narrows down to the entrance to the catching box which is situated about 5½ ft. above the ground, a wooden ramp leading up from ground level to the catching box entrance. The usual drop door and lock-up, which was used on the Point Pelee trap, has been dispensed with; this has been made possible by the use of a very efficient catching box. Likewise a banders' door through the side of the trap has not been built, and consequently the problems of construction have been greatly simplified.

It should be noted that the entrance and roof are higher than is generally recommended for a conventional Heligoland trap. It is more usual to have a flatter roof with the entrance 8-10 ft. high, this having the advantage that fewer birds are lost flying back beneath the roof. Although the cover in the entrance of the trap was reduced in height it was felt that to take full advantage of the site a higher trap than normal was needed. In addition the long wing walls were built to the same height as the entrance of the trap and have proved very effective in guiding birds into the trap entrance.

The details of the catching box are shown in Figure 3. Essentially it consists of a glass backed box divided into three compartments. Birds enter the upper compartment and land on a delicately balanced hinged metal platform, whereupon they drop down into the lower compartments. The metal platform is designed so that it hinges downwards only and birds cannot force their way out by fluttering upwards against the glass. The floor of the second compartment consists partly of plywood and partly of a grille which allows smaller birds to drop down into the third compartment. Birds are removed through sleeves in the side of the box. It is sometimes found that birds hop from one compartment to the other, through the grille, when the trapper is trying to remove them from the box. A slot in the side of the box allows a thin piece of wood to be inserted over the grille, which prevents birds moving between the two compartments.

The trap is sited near the end of a line of bushes on the northern shore of the point, the entrance facing southeast. The tops of some of the trees in front of the trap have been cut off so that they are about 18 inches below the roof level, with the result that fewer birds fly over the trap.

A few birds are caught automatically, but the great majority are caught by driving them into the mouth of the trap from some distance away. Grain has sometimes been placed in the entrance of the trap as bait, and has considerably increased catches of Bobolinks and sparrows.

MIST-NETS

Japanese mist-nets of three mesh sizes have been used at Long Point: 1½, 2½ and 4 inch stretched mesh. The 1½ and 2½ inch mesh nets are either 9 or 12.5 metres in length and 2 metres high with four shelves.

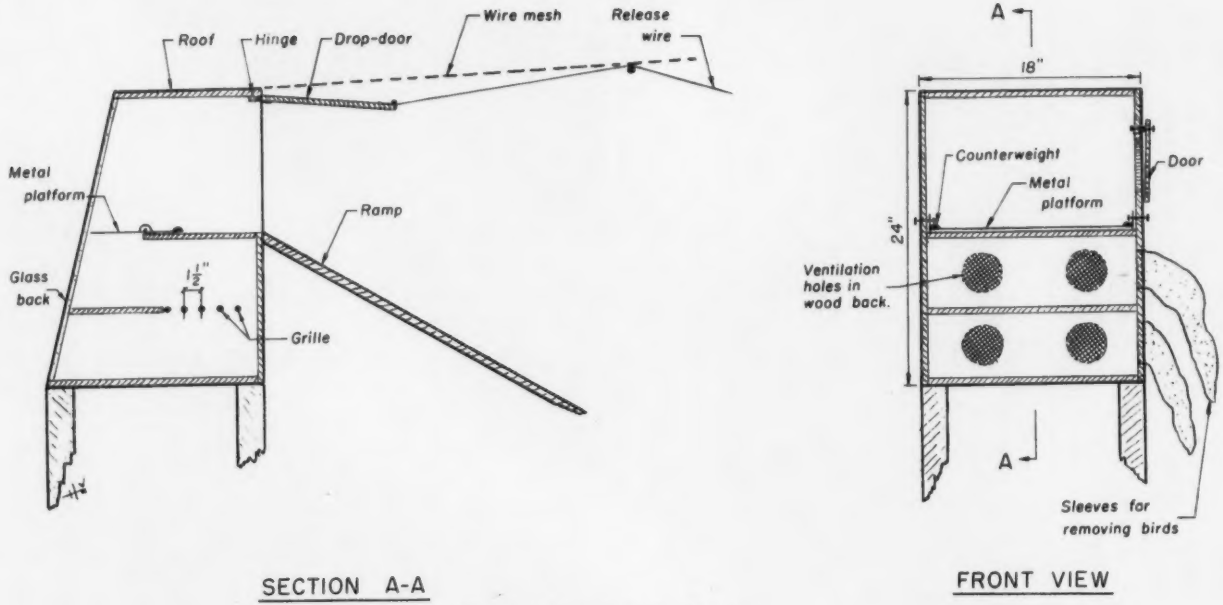

Figure 3. Details of Catching-box.

The 4 inch mesh nets are 18 metres long and 2 metres high with either one or two shelves. The 1½ inch nets are made of silk and the 2½ and 4 inch nets are nylon.

The greatest number of birds are taken in 1½ inch mesh nets; up to 10 nets have been used at one time but the usual number is 4 to 8.

The operation of the nets is similar to that described by Woodford *(op. cit.)* for Point Pelee and no further description need be given here.

COMPARISON OF CATCHES

The Heligoland trap first became operational on May 6, 1960, although the construction was not then complete. Additions and changes were made during the summer, and the trap reached its present form in September. During the period from May 6 to November 20 careful records were kept of birds trapped and netted, most of these being caught during the migrations in May and September.

Records are available for 3,140 birds of 106 species as to whether they were taken in the Heligoland trap or mist-nets. This total represents over 96% of the birds caught by these two methods during this period. The totals are set out in Table 1. 1,513 birds of 93 species were netted and 1,627 birds of 88 species were trapped. These totals exclude re-trapped birds.

The percentage of the six commonest families in the totals trapped and netted are shown in Table 2. Looking at the same data in another way, Table 3 shows the percentages trapped and netted for the same six families, together with the total number of each family taken.

Examination of the figures in Tables 1, 2, and 3 shows that some species and families were taken much more frequently by one method than the other. Notably sparrows were taken in greater numbers in the trap and flycatchers in nets. For some species the ease of trapping or netting is particularly obvious, as can be seen from Table 2. For instance American Goldfinches tend to fly high when driven and are therefore much more readily taken in nets, while Brown Thrashers can easily be driven into a trap but seem to have a remarkable ability for bouncing out of nets.

It should be pointed out that although these figures do to some extent indicate the potentialities of mist-nets and Heligoland traps, no direct comparison can be made between the totals; they simply represent the totals of birds that were caught by the two methods during one season at Long Point, using a particular Heligoland trap, and a varying number of mist-nets. At another location the figures would probably have been quite different, and this is confirmed by comparison with the figures for Point Pelee (Woodford, *op. cit.)* which show no very obvious parallels with those from Long Point. In addition to the different locations, the periods when the two stations were manned will have had an effect on the results, while the high percentages of swallows taken at Pelee can be accounted for mainly by one exceptional movement in May, 1956.

TABLE 1. Species and Individuals taken in Mist-Nets and Heligoland Trap, 1960

Species	M.N.	H.T.
Least Bittern	1	
Sharp-shinned Hawk	22	2
Cooper's Hawk	1	
Marsh Hawk	1	
Common Snipe	2	
Spotted Sandpiper	5	
Short-billed Dowitcher	1	
Semipalmated Sandpiper	2	
Sanderling	6	
Mourning Dove		4
Yellow-billed Cuckoo	2	1
Black-billed Cuckoo	1	
Long-eared Owl	1	
Saw-whet Owl	1	1
Whip-poor-will	2	1
Belted Kingfisher		1
Yellow-shafted Flicker	23	
Red-headed Woodpecker	23	2
Yellow-bellied Sapsucker	13	3
Downy Woodpecker	2	3
Eastern Kingbird	6	
Great Crested Flycatcher	3	3
Eastern Phoebe	2	4
Yellow-bellied Flycatcher	40	9
Acadian Flycatcher	3	
Traill's Flycatcher	3	3
Least Flycatcher	21	4
Empidonax sp. (unidentified)	33	16
Eastern Wood Pewee	35	3
Horned Lark	1	
Barn Swallow	11	
Blue Jay	10	7
Black-capped Chickadee	16	1
Brown Creeper	67	8
House Wren	8	7
Winter Wren		2
Catbird	20	18
Brown Thrasher	5	23
Robin	1	1
Wood Thrush	3	3
Hermit Thrush	6	14
Swainson's Thrush	50	34
Gray-cheeked Thrush	8	9
Veery	7	4
Eastern Bluebird		1
Blue-gray Gnatcatcher	2	3
Golden-crowned Kinglet	25	42
Ruby-crowned Kinglet	50	41
Cedar Waxwing	3	7
Solitary Vireo	1	2
Red-eyed Vireo	23	6
Philadelphia Vireo	10	1
Warbling Vireo	7	
Black & White Warbler	6	7
Tennessee Warbler	10	19
Orange-crowned Warbler	1	2
Nashville Warbler	22	32
Yellow Warbler	7	6
Magnolia Warbler	41	29

Species	M.N.	H.T.
Cape May Warbler	51	50
Black-throated Blue Warbler	8	1
Myrtle Warbler	57	62
Black-throated Green Warbler	8	6
Blackburnian Warbler	8	2
Chestnut-sided Warbler	10	2
Bay-breasted Warbler	18	5
Blackpoll Warbler	97	103
Palm Warbler	25	58
Ovenbird	7	4
Northern Waterthrush	9	5
Connecticut Warbler	2	4
Mourning Warbler	1	1
Yellowthroat	17	20
Yellow-breasted Chat	3	6
Hooded Warbler		1
Wilson's Warbler	11	3
Canada Warbler	5	3
American Redstart	24	7
House Sparrow		3
Bobolink	4	72
Eastern Meadowlark	2	
Redwinged Blackbird	55	22
Orchard Oriole		1
Baltimore Oriole	17	5
Rusty Blackbird		10
Common Grackle		3
Brown-headed Cowbird	1	11
Scarlet Tanager	6	3
Rose-breasted Grosbeak	19	10
Blue Grosbeak		1
Indigo Bunting	2	3
Dickcissel	2	2
Purple Finch	2	
American Goldfinch	68	6
Rufous-sided Towhee	14	9
Savannah Sparrow	12	10
Grasshopper Sparrow		1
Slate-colored Junco	11	58
Tree Sparrow		6
Chipping Sparrow	6	17
Field Sparrow	6	6
White-crowned Sparrow	73	301
White-throated Sparrow	122	307
Fox Sparrow		1
Lincoln's Sparrow	29	12
Swamp Sparrow	11	2
Song Sparrow	14	13
Total	1513	1627

MIST NETS VERSUS HELIGOLAND TRAPS

The advantages and disadvantages of mist-nets and Heligoland traps have been discussed by Williamson *(op. cit.)* and Woodford *(op. cit.)*, and may be summarized as follows:

Mist nets have the advantage of being portable and easily set up, able to cover a wide area, and be moved to take advantage of local movements; a large number of nets can be operated by a single person

TABLE 2 Family percentages of Birds taken in Mist-Nets and Heligoland trap

Mist-Nets		Heligoland Trap	
1. Parulidae	29.6%	1. Fringillidae	47.0%
2. Fringillidae	25.8	2. Parulidae	26.9
3. Tyrannidae	9.6	3. Icteridae	7.6
4. Icteridae	5.2	4. Sylviidae	5.3
5. Sylviidae	5.1	5. Turdidae	4.1
6. Turdidae	5.0	6. Tyrannidae	2.6
Others	19.7	Others	6.5
	100.0		100.0

and they are low in initial cost. Their disadvantages are that they are rendered inoperable by strong winds and wet weather, they cannot be left unattended, each bird must be removed individually, which takes time and requires an experienced operator, birds may lose parasites or old feathers, and they have a limited period of usefulness.

Heligoland traps can be operated in any weather conditions, and are made operational simply by setting the catching-box, from which birds may be easily and quickly removed. Frequent inspection is not necessary, the occasional bird caught automatically will remain quietly in the box until removed. The disadvantages are that they are usually beyond the resources of individual banders due to the high initial cost and time needed for construction, they operate in a fixed position and cover only a limited area, and a crew of 2 to 4 is preferable (although not essential) for their operation.

Williamson *(op. cit.)* particularly emphasized the advantages of traps on an exposed island. It should not be thought, however, that this means that traps have no application in less severe climatic conditions than those found on Fair Isle. The trap site at Long Point is in an exposed situation with relatively thin cover, and on some days mist, rain or strong winds either rendered mist-nets inoperable, or substantially reduced their efficiency without adversely affecting trap use.

For instance, on the 18th of May, although a heavy fog dampened the nets and made them virtually impossible to use, the one bander present was able to take 67 Bobolinks in the Heligoland trap, from an influx that took place early in the day. However, conditions such as these were exceptional at Long Point and on most days both the trap

TABLE 3 Percentages taken in Mist-Nets and Heligoland trap for six commonest families

	Total	% M. N.	% H. T.
1. Fringillidae	1156	33.8	66.2
2. Parulidae	886	50.5	49.5
3. Icteridae	203	38.9	61.1
4. Tyrannidae	188	77.7	22.3
5. Sylviidae	163	47.2	52.8
6. Turdidae	141	53.2	46.8
Others	403	73.7	26.3

and nets could be used, and it will be shown that both methods played an important part in the numbers of birds taken.

An important advantage of nets is that on a quiet day one man can conveniently operate a large number of nets, possibly up to 25 or 30, while it is preferable to have more than one trapper to operate a Heligoland trap effectively. On the other hand it has been found that when there are many birds present, one man can handle more birds by using a Heligoland trap than mist-nets, although a higher proportion of birds are lost in driving into the trap than would be the case if there had been several trappers.

No attempt was made at Long Point either to trap particular species or to standardize trapping methods, but rather banders operating the station were left to catch as many birds as possible by the methods available. On most days weather conditions allowed the use of both nets and the trap. Banders soon discovered that on days when there were few birds present driving the trap would produce only a small number of birds, and it was easier to set up several nets and wait for birds to get caught in them. On the other hand when there was a large influx of migrants so many birds were caught both in the trap and in nets that it was often found necessary to furl some of the nets in order to keep up with them. In some cases all the nets were furled and only the Heligoland trap used, the reason being that it takes less time to handle birds taken in the trap than those taken in nets. A full-scale drive of the trap takes about 15 minutes to complete including removal of the birds from the catching-box and placing them in gathering cages. The largest single catch recorded during the year resulted from one drive by two men on September 27: 107 birds were caught including 74 White-throated Sparrows. Catches of this size should be avoided if possible; catches of 20 or 30 birds are more conveniently handled, and are quite common at Long Point.

As previously mentioned an average of 4-8 nets was used at Long Point, together with the Heligoland trap, and over the season as a whole approximately the same number of birds were caught by the two methods. It might therefore be thought that they were roughly equivalent in trapping value; however, the manner of operation indicates that no such conclusion can be drawn, since the amount of effort expended on each method varied according to the number of birds present. In fact, at Long Point mist-nets and the Heligoland trap were used as complementary techniques. If there had been no trap, more nets would have been used on peak days and consequently more birds would have been netted. On the other hand if no nets had been available more effort would have been put into driving the trap on days when few birds were present. It is equally difficult to suggest any general figure for the number of nets that can be considered equivalent to one Heligoland trap since their value will vary according to the location. Experience of both techniques and an appreciation of their relative capabilities will be helpful in deciding on their suitability in a particular location.

It is of interest to look more closely at typical examples of the complementary use of mist-nets and the trap. On May 16 there was a heavy influx of White-crowned Sparrows. One bander was present and he furled all nets at noon. Up to that time 66 birds had been caught in nets at 1.6

birds/net-hour. By contrast on the following day, May 17, the same bander caught 56 birds in mist-nets at 0.8 birds/net-hour and 42 birds in the Heligoland trap at 3.5 birds/trap-hour. Similarly on September 26 there were few birds present and one bander caught 29 birds in nets at 0.9 birds/net-hour and 34 birds in the trap at 6.8 birds/trap-hour. On the following day, September 27, there was a large increase in the numbers of White-throated Sparrows and other migrants. With the exception of one 4 inch mesh net, no nets were set up, and 160 birds were caught in the Heligoland trap at approximately 60 birds/trap-hour, with the assistance of one cooperator.

Although the figures quoted for birds/trap-hour should not be taken too literally, as it is difficult to decide for how long the trap is operating and the numbers caught depend largely on the number of drives made, the general trend is indicated and it is clear that at Long Point the Heligoland trap is much more efficient than mist-nets in dealing with large waves of migrants. This also accounts in part for the predominance of sparrows amongst birds trapped, since during 1960 large peaks of White-crowned and White-throated Sparrows occurred on a few days when nets were only sparingly used.

The success of the trap at Long Point has resulted in plans being made to build others, and two are at present under construction. It is anticipated that mist-nets will continue to be used extensively at Long Point in order to take advantage of their greater versatility, as evidenced by the greater number of species taken in nets; but it is thought that as more traps are built the use of 1½" mesh nets for general trapping of small birds will be greatly reduced, the larger mesh nets being used to take species, particularly shore birds and hawks, which are not readily caught in Heligoland traps.

It seems probable that Heligoland traps would be equally effective at other locations in North America where conditions are similar to those at Long Point. Exposed coastal areas with thin cover, which are subject to large waves of migrants, are ideal for their use.

ACKNOWLEDGMENTS

Our thanks are due to the Canadian Department of Transport, the Long Point Company, and the Ontario Department of Lands and Forests for granting permission to trap and band birds on their properties. The Federation of Ontario Naturalists has provided financial assistance.

The results described in this paper represent the combined work of many members of the Ontario Bird Banding Association, who have cooperated in establishing the Long Point Bird Observatory.

The sketch of the catching box shown in Figure 3 was drawn by Mr. Harold Vanstone.

SUMMARY

1. A Heligoland trap was built at Long Point, Ontario, during the spring of 1960.
2. In general the trap is of conventional design, consisting of a large wire-netting funnel erected over a line of bushes. An automatic catching-box proved to be very efficient, and consequently the usual "drop door" and "lock-up" were not utilized.

3. Japanese mist-nets of 1½, 2½ and 4 inch stretched mesh were used in the same area.
4. Records are available for 3,140 birds of 106 species caught between May 6 and November 20, 1960, as to whether they were taken in nets or the trap. 1,513 birds of 93 species were netted and 1,627 birds of 88 species trapped.
5. A comparison was made of the species and families of birds caught by the two methods and it was found that some were taken much more frequently by one method than the other. In particular 66.2% of the sparrows taken were trapped, while 77.7% of the flycatchers taken were netted.
6. The operation of the Heligoland trap and mist-nets at Long Point is discussed, and it is concluded that the trap was more efficient in dealing with large influxes of migrants, but that the nets were more versatile. Heligoland traps should be advantageous in exposed situations with thin cover, where sizeable waves of migrants occur.

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CONSTRUCTION AND USE OF HELIGOLAND TRAPS*

BY JAMES WOODFORD AND D. J. T. HUSSELL

The Heligoland trap, a large wire-netting funnel, has been used in Europe for many years to catch large numbers of birds, principally migrants. Despite a greater number of co-operators and of birds banded in North America, the Heligoland trap was apparently not used until 1954, when one was constructed at Point Pelee, Ontario (Gunn, 1954). There were reviews of reports of the stations at Heligoland and Rossitten in *Bird-Banding* (C.L.W. [Whittle], 1930 *et subsq)*, in which the traps were mentioned. Lincoln and Baldwin (1929) did not mention Heligoland Traps in "*Manual for Bird Banders.*"

The purpose of this paper is to review the techniques of construction and operation of Heligoland traps in the light of recent experience at Point Pelee (Woodford, 1959) and Long Point, Ontario (Hussell and Woodford, 1961), and to discuss their possible further application to

*A publication of the Ontario Bird Banding Association.

North American conditions. In so doing, we have drawn heavily on the available European literature.

HISTORICAL

The Heligoland Trap was originally developed by Dr. Hugo Weigold from the Troosel-goards or "Thrush-bushes" which were used by the Heligoland islanders to catch migrant thrushes for food.

Gatke (1895), in *The Birds of Heligoland*, described the troosel-goards as follows: ". . . A space about 20 ft. long, and from 6 to 8 ft. broad, is surrounded by a fencing of bushes, 10 ft. high, and placed fairly close together, so that there is just room enough left between them to allow the thrushes to run comfortably through at the bottom. The bushes forming one of the long sides of this arrangement are put up perpendicularly, those of the opposite side in such a manner as to incline towards them. Over this latter side a strong net is stretched, reaching from the top of the bushes to within 2 ft. of the ground, and enclosing one side of the enclosure in a long semi-circle; a second net of strong thread loosely strung on a line, is stretched tightly by means of the latter round the lower portion of the same side of the thrush-bush. Below, however, this net is spread loosely on the ground for a distance of 6 ft. from the bottom of the bushes; in this manner, the depth of the whole arrangement is considerably increased . . . the thrushes, used to shady woods, are powerfully attracted by the few dead twigs and bushes stuck in the ground, and hasten towards them with the utmost readiness. Once inside the bush they are, by means of long sticks, driven without much trouble to that portion of the net which lies loose on the ground, where for the most part they stick their heads through the meshes, and are unable to get back again."

Weigold (1956) describes the first trap which was built about 1919 or 1920. This led to the founding of the world-famous "Fanggarten," or ringing garden, which on barren Heligoland offered shelter to migrant birds. It was simply a planted area surrounded by a cat-and human-proof fence and containing three small and one large funnel or Heligoland traps. An article in *British Birds* by W. B. Alexander (1934) contained a description and photographs of the ringing garden.

The first Heligoland traps were constructed on Heligoland Island (as mentioned above) and at Rossitten. In the British Isles the first were erected at Skokholm in 1933 and on the Isle of May in 1934 (Lockley and Russell, 1953).

DESIGN

Although no two Heligoland traps are exactly the same, most are patterned on a basic model, described by Brownlow (1952) as: ". . . a tapering wire netting enclosure open at the wide end, and closed at the narrow end by a collecting box with a transparent back, which appears to birds driven into the trap as a way of escape, and induces them to enter the box." As Williamson (1957) points out it is often, ". . . expedient to modify the design and construction of the traps to suit the terrain, and exploit to full advantage the natural behaviour of the migrant birds."

The size and shape will depend primarily on the site and resources available for construction. Of secondary consideration is the number of trappers available to operate the trap or traps. It is generally thought that a long, low trap is most effective. However, the results at Point Pelee and Long Point show that numbers may be taken in a trap having a relatively high entry and catchment area.

It is essential that the trap be constructed so that it presents the birds driven into it with a "point of no return" (Brownlow, *op. cit.)*, beyond which the transparent back of the catching-box appears as the only, or at least the most obvious way of escape. This is accomplished by progressively angling the direction of the trap (particularly the funnel area), usually in two stages, so that a bird near the catching-box can see only netting behind it. If possible the roof of the last section of the funnel area should slope up towards the catching-box. The changes in direction should not be too sudden; some trappers, particularly in Scandanavia, recommend curving part of the catchment and the funnel area roughly in a quadrant.

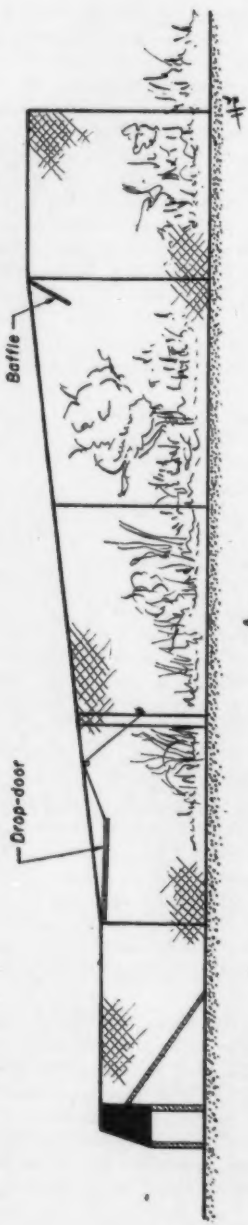
The principle of the Heligoland trap may be used in various situations. Brownlow *(op. cit.)* and Williamson *(op. cit.)* describe several variations of the Heligoland Trap. The "Gully" or Vaadal traps which consist of a wire-netting roof carried on girders or cables across the upper ends of steep-sided and narrow gullies, the upper end of which is closed by a funnel and a catching-box. The Double or "Double-Dyke" traps used at Spurn and Fair Isle were designed to catch birds such as the Wheatear, which move along the stone-walls on Fair Isle and to be convenient for both migration movements at Spurn, which is a peninsula. They were first built with the two entries facing in opposite directions, but sharing a common funnel and catching-box. This was not satisfactory, as the change in direction was too great. They were later fitted with separate funnels, properly angled. The "Double-Dyke" trap at Fair Isle actually straddled a stone-wall. "Ditch" traps have been built at points where a natural hollow or ditch runs alongside a wall; these are more economical to build than the Double traps.

Brownlow *(op. cit.)* describes portable Heligoland traps, simply light wood or metal frames, covered with netting, and with a catching-box. They were designed so that they could be set up in an hour or two to take advantage of a local movement of birds. This was before the era of the mist-net, which does this much more easily and effectively.

Hollom and Brownlow (1955) describe portable "Minigoland" Traps, which are a combination of the Heligoland funnel and a drop-door trap.

For descriptive purposes the Heligoland trap may be divided into four areas (see fig. 1).

Assembly area—This is the area immediately in front of the trap, including the area within the wing-walls. There should be adequate cover (bushes, trees) leading into the trap. It is very important that this be somewhat lower than the entry, perhaps 2/3 its height, otherwise some birds are likely to fly up and over the trap. The cover should not be too dense or some "skulking" species may find temporary refuge there and the trappers may miss driving them into the trap. Any cover at the sides of the entry which might lead birds away from the trap should be removed.



A.

Figure 1. Heligoland Trap
A. Side View

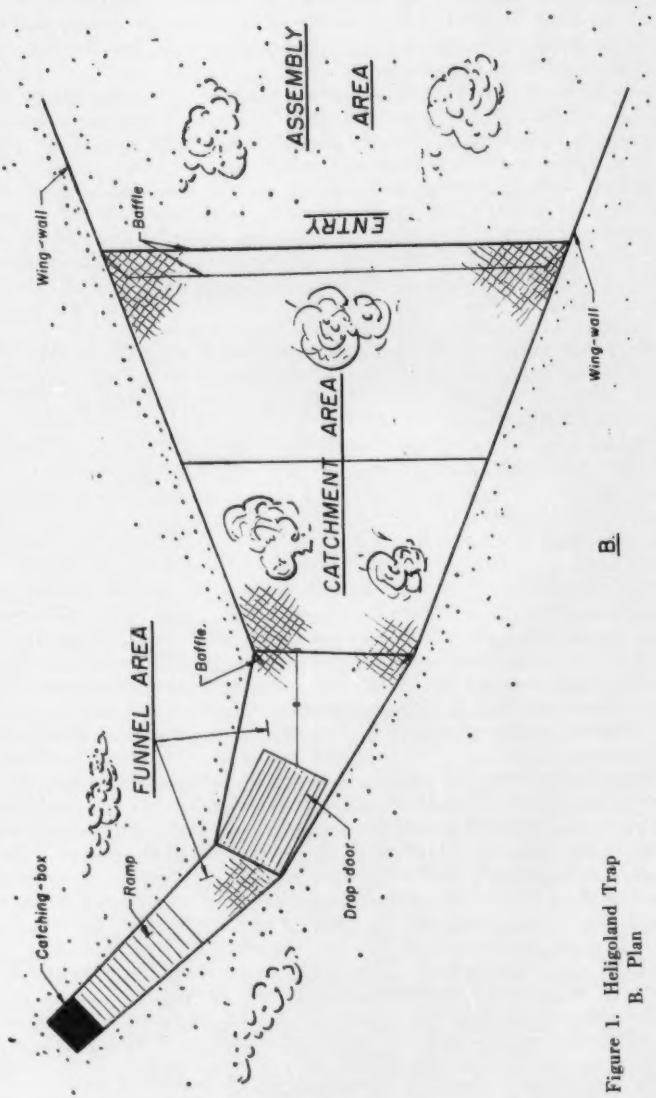


Figure 1. Heligoland Trap
B. Plan

On most traps the assembly area is partially "enclosed" by wing-walls which lead out from each side of the entry. These may be of varying length, usually 10 to 20 feet and from 6 to 15 feet high. Wing-walls the same height (15 feet) as the entry have proved very effective at Long Point. The wing-walls tend to guide birds into the trap and prevent them from by-passing the entry.

Catchment area—This is the main body of the trap. It is wide (15 to 35 feet) at the entry and some 20 to 40 feet long, narrowing down to 3 to 6 feet. The height drops from 8 to 20 feet at the entry to 6 to 8 feet at the beginning of the funnel.

Baffles, both horizontal and vertical, should be placed at the entry and at other points in the catchment area. These are strips of ½ inch wire-netting, 1 to 3 feet wide, and sloping inwards at about 60° to the main wire-netting of the trap. These tend to prevent the escape of many of the birds which break back along the walls or roof towards the entrance, by confronting them with a "wall," which causes most of them to turn again and fly towards the funnel area.

Brownlow *(op. cit.)* recommends stretching a wire across the entry about a foot below the roof to act as a perch for flycatchers *(Musicapa sp.)*. Although the behaviour of American flycatchers may be different this might still be useful.

Funnel area—This is also called the "lock-up." It is a narrow, sharply converging passage leading from the catchment area to the catching-box. On many traps this area may be closed, when desired, by a drop-door, which is controlled from a point in the catchment area. Once the door has been dropped the birds are confined to a relatively small area, and there is not the danger of them flying back out the entry. However, a drop-door is often difficult to install and operate efficiently. There may also be a trapper's door, leading to the outside from the funnel area. This saves trappers having to go round by the entry to get to the catching-box. The trap at Long Point has no doors; the drop-door was not found to be necessary due to the efficient catch-box and the driving technique, and the trapper's door was not built for reasons of economy. A trap with no doors simplifies construction and lowers the cost.

The principal changes in direction, which present the birds with "a point of no return," are usually made in the funnel area. In most traps there are two "bends," so that the catching-box will be angled about 35° to 50° from a line drawn through the center line of the entry. This is usually accomplished by having two sections of narrow passageway. The first 6 to 8 feet long, and virtually devoid of cover; and a second 8 to 12 feet long, containing the ramp, which leads up to the catching-box. If possible the roof of this last section should slope slightly upwards to the catching-box. This helps in creating the illusion of a "point of no return," the birds fly naturally upwards.

The ramp leads from the ground up to the catching-box. It should be solid, offering the birds no means of escape, and strong enough to support the weight of a trapper who may want to catch by hand a bird in the upper compartment of the catching-box.

Catching box: This is a box with a transparent back, shelves to divide the box into compartments, an opening to the funnel and some means

of removing the birds. Several types of catching-boxes are in use and have been described by Brownlow *(op. cit.)*, Lockley and Russell *(op. cit.)* and Hussell and Woodford *(op. cit.)*. A simple yet effective one is shown in figure 2.

Some workers favour a fairly large catching-box, as sometimes large numbers of birds are caught in one drive. However, this leads to difficulty in removing the birds, unless some sort of "piston" arrangement to reduce the box area is used, which is not too practical on most boxes. A medium sized box—perhaps about 18 inches square and 2 feet high—is a useful size. There is enough room to accommodate a good number of birds, yet a trapper can easily reach any part to remove a bird.

The box should be at a convenient height from the ground, so that a trapper will have no trouble getting his arm in the box, 3 to 4½ feet is an ideal height, although steps and a platform can be built if necessary.

The box is divided by shelves into two or three compartments. The upper one opens to the funnel, and birds seeing sky or landscape, through the transparent back, fly in and flutter against the glass. Then most drop down into the lower compartment, where they usually remain until removed by the trapper. Some boxes have two lower compartments, separated by a floor which is part wood and partly a grille of metal rods, spaced 1¼ to 1½ inches apart. The grille allows small birds to drop to the lowest compartment. On some boxes this is accomplished by having a "small-bird" box, attached to the side of the catching-box, with a grille vertically between the two.

Details of construction will be discussed in a later section.

SITE

The trap-site must be carefully chosen in an area where a variety of species occur in numbers during migration. It is recommended that possible sites be kept under observation for at least one year, noting carefully the local movements of migrants.

Traps have been built in various situations. A good one is near the end of an isolated, narrow line of low cover. The best cover is bushes, with some small trees, but *no* high trees in front or behind the trap, as this will encourage some species to fly over the trap. If possible the trap should be protected from the wind, Brownlow *(op. cit.)* recommends a natural hollow as an ideal site.

Other situations where traps have been built are: around an isolated clump of evergreens (Long Point), across a narrow valley, along stone-walls, over the exit of a small stream (Fair Isle), in an enclosed garden (Heligoland), around a bush overgrown with vines (Long Point) and on barren islands artificial cover (rolls of rusted netting or barbed wire, driftwood, etc.) may be used and the trap built around it.

The mouth should, if possible, face the direction of migrants' local movements at the season when it is likely to be most productive. As previously noted, "double" traps, along stone-walls, have been built at Fair Isle, the two mouths facing opposite directions.

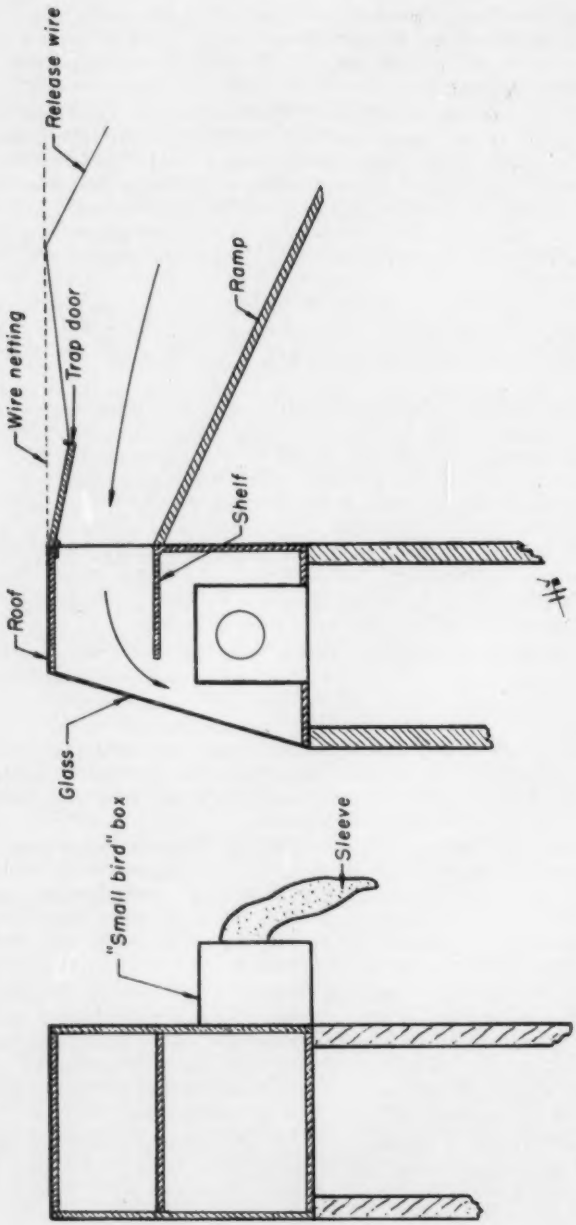


Figure 2. Details of Catching-box

CONSTRUCTION

Tools: The following are recommended as useful in building Heligoland traps:

Shovel—long-handled and short-handled.
Post-hole digger—effective in some situations.
Saw—"Swede" or cross-cut—for cutting larger poles; hand saw for general cutting.
Axe—one with a good blade and heavy head.
Hatchet—useful for recessing poles to set in cross-pieces.
Hammer—several.
Crow-bar—especially if salvaged lumber is being used.
Tin-snips—to cut wire-netting.
Pliers—to cut and twist wire used in "sewing."
Tape measure—10′ and 50′.
Level—to line up posts and platform for catching-box.
Staple-gun—useful in attaching wire-netting to uprights.
Rope—to haul cross-pieces into place.
Ladder—10 to 20 feet long; a one-inch board about 8 inches by 3 feet nailed to one side allows a ladder to be leaned against the the wire-netting without bending it badly. A step-ladder is also of use.
Gloves—ones with leather palm are sometimes useful in handling wire-netting.

Materials: A variety of materials are necessary for the construction of a Heligoland trap. Considerable savings may be effected by utilising used lumber for the framework. At Long Point frameworks for two traps have been built from wood found along several miles of uninhabited beach.

Lumber—posts for uprights, 4 to 10 inches in diameter and 10 to 30 feet long.
2 x 4's and 2 x s—for uprights and cross-pieces.
1 x 6 to 12 inch flooring—for ramp.
waterproof plywood—⅝ to 1 inch, for catching-box.
1 x 4—to build framework for drop—or trappers' door (if used).
Wire-netting—½, 1, 1½ inch mesh of a fairly heavy grade and in the largest width available.
Nails—6, 4, 2½ and 1½ inch.
Staples—¾ to 1 inch.
Wire—good supply of wire usually referred to as "stove-pipe" wire—no. 16-18.
Glass—sheets of double-diamond to fit catching-box.
Misc.—hinges for catching-box and doors, catches for doors, sheet metal for treadle, wood preservative, etc.

Framework: The framework of the catchment and funnel areas consists of a number of uprights or posts, laid out roughly in pairs, and gradually diminishing in height and width from front to back. Each upright is joined at the top by cross-pieces, both laterally and along the length of the trap. A variety of materials may be used for the uprights—wooden posts or poles are ideal; pipe (1 to 2 inch) and angle-iron have also been used. At Long Point wooden posts (5 to

10 inches in diameter) have been used for some of the uprights; 2 x 4's and 2 x 2's were also used, especially in the funnel area.

The uprights should be sunk in the ground at least 18 inches in firm conditions and up to five feet in sand. If pipe or angle-iron are used as uprights they may have to be set in concrete—possibly about 2 feet deep and 1 foot in diameter. It is wise to treat the bottom sections of wooden posts with wood preservative.

The cross-pieces may be 2 x 4's, 2 x 2's or smaller. A sturdy cross-piece makes for more rigid construction, although some workers contend that it makes the roof more obvious. They recommend that wire be used instead of wood to support the roof; however, this means that the uprights would have to be braced, either by guy-wires or wooden supports.

The ramp, which leads up to the catching-box, should be of fairly solid construction, so that it will support the weight of a trapper if necessary. It is best to build the ramp before the wire-netting is attached. Two supports, either 2 x 4's or 2 x 2's, should run from the ground to just below the catching-box. These should be placed so that there will be no gap between the ramp and the wire-netting of the wall. These supports should be covered by 1 inch flooring, 6 inches or more wide.

The ramp should be built at such an angle that a bird alighting near its base will be able to see the sky or landscape through the transparent back of the catching-box.

Some ramps have a 1 by 4 inch board running up each side, along the wire-netting, to try and prevent birds from sticking their bills or heads through the netting. This is not always effective as often the bird hops up on the board, and proceeds to stick its bill through.

Doors—drop or trappers'—will complicate the construction of the trap. If they are used they should be set into carefully constructed frames; otherwise birds will escape through gaps left if the door does not shut tightly. A drop-door is best hinged at the top to a sturdy horizontal cross-piece of the frame. The top of the frame should be sloped back towards the catching-box about 15 to 20°; then the door will be kept shut by gravity. The door should be controlled by a wire led back to a point in the catchment area by small pulleys or tubes. Cord is unsatisfactory as it stretches. It is sometimes helpful to fasten a strip of ½ inch wire-netting, about 6 inches wide, around the inside of the frame, as an additional deterrent to birds trying to escape. The trappers' door may be hinged on the side. Brownlow *(op. cit.)* describes a useful device for keeping the trappers' door shut as: ". . . boring a hole through the upright of the frame at a convenient height, pushing a metal rod through the hole and bending its ends at right angles close to the upright so that they can swing to embrace the closed door. A nail on the inside and on the outside of the door on which they can rest in the closed position completes the device, which is easily operated from either side."

Wire-netting: On most traps this is the major expense, but it is false economy to use poor quality wire-netting because it will not stand-up to the weather. The finer the mesh the higher the cost yet ½ inch mesh should be used on most of the trap, otherwise many birds will escape.

The walls and roof of the funnel, the walls of the catchment area and if possible the wing-walls should be of ½ inch mesh. If a drop-door or trappers' door are used they should be covered with ½ inch mesh.

The wire-netting should be buried at least 6 inches in the ground. Trenches, about 6 inches deep should be dug along the walls before the netting is put in place. After the bottom section of netting is in place the trench may be filled in.

Adjacent sections of netting should be overlapped, at least 3 times the mesh-size (e.g. ½ inch should overlap 1½ inches). They can then be sewn together with wire, number 16-18. The job of sewing, if left until after the wire is on the trap, is best done by two people, one on either side so they can thread the wire back and forth through the netting. It is much easier to join the sections together before they are put in place. A section of the trap wall, or a wing-wall, may be "prefabricated" on the ground, stapled to the horizontal cross-piece and then hoisted into position. This requires careful measuring and adequate working room on the ground. Make sure the area is clear of debris before laying the wire on the ground.

Sewing the wire netting joints is very time consuming and it is, therefore, advisable to get wire-netting of the greatest width obtainable.

Brownlow (1955) mentions that wire-netting is liable to corrosion when the trap is sited near salt-water. He recommends painting the netting with black bitumastic paint or with tar. This also tends to make the wire-netting, and thus the trap, less conspicuous.

Catching-box: An excellent material for the construction of catching-boxes is outdoor plywood—either ⅝ or ¾ inch, for the frame and ⅜ or ½ inch for the shelves. The best material for the transparent back is a sheet of glass. This should slide in and out by means of grooves so that the trap may be put out of action if it is not being used. The glass should slope, because a slope tends to deflect downwards to the lower compartment of the box, and also the impact of a bird flying against the glass is reduced. The slope should be about 50°. Plastic such as "perspex" may be used instead of glass, but it soon discolors and is difficult to clean. If several traps are being built in one locality it is a good policy to make all the catching-boxes of one size, as then only one size of sheet glass is needed as a spare.

Circular openings to remove birds (about 6 inches in diameter) should be cut in the side of the box, one for each compartment, including the top one. These must be closed by either shutters or sleeves. A shutter, simply a circle of plywood 8 inches in diameter and hinged by a single screw at the top, may be used to close the opening to the upper compartment. A square shutter, running in two "tracks" may also be used. The lower openings may be closed by cloth sleeves, about 6 inches in diameter and 12-16 inches long. The sleeve may get damp and difficult to use in wet weather. This may be partially overcome by building a "roof" over the sleeves. Part of an old trouser leg, especially denim, makes a good sleeve.

Mather (1960) describes another alternative to sleeves or shutters. A piece of pure sheet rubber—3/16 inches thick—is fastened over the opening in the catching-box. Then two cuts the length of the opening are made, dividing the area into four equal parts; each part is then

bisected by a cut one-quarter the diameter. The hand may then be inserted and extracted, with the rubber springing back into place after each insertion/extraction.

It is a good policy to have some ventilation holes (4-6″ circles, covered by fly-screening) in the front of the box, particularly when birds may be caught automatically and be in the trap for a short period of time, possibly between drives or the trapper's regular visits.

On some boxes a metal platform or treadle is used, between the glass back and the floor of the top compartment. This makes the box "automatic." A bird fluttering against the glass eventually alights on the treadle, which tilts down, dropping the bird into the lower compartment. Once the bird is in the lower compartment it does not have much chance of escaping by fluttering up along the glass, as is the case in the box shown in fig. 2. Brownlow (1952) figures a treadle used at Fair Isle. This is a light metal plate, which pivots on a central pin and is balanced to return to the normal position against a stop. However this has the disadvantage that occasionally when a bird activates the treadle and drops into the lower compartment another bird, already in the box, may escape out the other side, which tilts upwards. This can be overcome by hinging the treadle near the back (see Hussell and Woodford, 1961) so that the whole treadle tilts downwards, with no space at the back. If a centrally-pivoted treadle is used it will be necessary to increase the gap between the glass and the top shelf from 3 to 6-8 inches.

A treadle increases the efficiency of the trap. Any birds which are self-caught (not driven in) cannot escape and may be picked up when the trap is next visited by a trapper. Some days this may amount to a fair number of birds. Secondly, an automatic box is more effective in confining birds once they are near the end of the funnel area, so that it is possible to dispense with the drop door, simplifying the construction.

COVER

The amount and position of cover is a very important factor in the number of birds caught. At most sites it will be necessary to do some "gardening," that is removing or trimming trees or bushes; and some planting. However no more cutting than is necessary to allow construction should be done until the trap is operating.

Any tall trees in the trap area, both behind and in front of the trap, may have to either be "topped" or removed. Bushes or trees at either side of the entry may have to be removed, as they may induce birds to by-pass the trap. Bushes or trees in the entry and catchment area should be considerably less than the height of the entry or the catchment area.

The cover in the entry and catchment should not be so dense as to hamper the movements of trappers driving the trap. Selective thinning may be necessary in some locations. There should be paths for at least four trappers through the cover in the assembly area. The walls of the catchment area should be free of cover as many birds tend to "fly-back" towards the entry along the walls and may find shelter in any cover near the walls long enough to be by-passed by the trappers driving the trap. A bit of cover, possibly a sapling, in the middle of

the narrow end of the funnel helps to slow birds down, before they enter the catching-box.

In some situations some planting may be necessary. Careful planting in the assembly and catchment areas, especially in barren and exposed areas, may greatly increase the number of birds naturally attracted to the trap area. It is wise to consult a horticulturist before doing any planting, to determine if the selected bushes or trees are suitable, particularly for the soil conditions. The rule followed at Long Point, and probably elsewhere, has been to obtain trees or shrubs from as near the trap-site as possible, as any items transplanted carefully have a very good chance of survival. There are a number of good references on planting to attract birds, such as Terres (1953) and Mackintosh (1956).

At Point Pelee wild vines eventually covered much of the trap, especially the wing-walls and catchment area. While this in some ways makes the wire-netting less conspicuous, there is considerable weight on the netting and the vines intertwine in the mesh so badly that they are difficult to remove. It also provides sufficient cover for some birds, so that they may be by-passed by the trappers. Snow is more likely to remain on a vine-covered roof and may cause serious damage.

Some writers advocate planting berry- or seed-bearing plants, which are attractive to birds, in or near the entry. This may be successful in some areas, although baiting insures a more constant food supply.

BAIT

One of the best lures is water. A small pool set in the ground, with water dripping into it, is most effective. A simple drip arrangement is a large tin can, suspended over the pool, with a hole in the bottom that will allow a drop to fall every few seconds. An uncovered feeding tray—2 feet square—may be set near the center of the entry. A variety of baits, such as millet, bread crumbs, mixed grain, sunflower seeds, may be used. Seed thrown on the ground may soon be covered over by the repeated visits of the trappers, especially in sand areas.

OPERATION

The operation of Heligoland traps has been described by Brownlow (1952) and others. Although some birds are trapped "automatically," most are driven into the trap. The birds may be attracted to bait or water near the mouth and then driven a short distance or several trappers may drive the birds some distance into the trap. The driving technique will vary with every trap and with the species of bird being trapped.

Under most conditions drivers should proceed as follows:

1. The trappers (2-6) should take up positions some distance from the trap, in a straight line or possibly the two outer trappers might be a little ahead of the rest.

2. They walk forward slowly, "beating" the vegetation with a stick (too much noise causes some birds either to fly back over the trappers' heads or out of the area entirely). It is important that the trappers keep in formation as birds are more likely to "break-back" if one trapper gets out of line.

3. Under *no* circumstances should a trapper break the line and attempt to bring back a bird that has slipped by. (Unless the bird in question is a rarity and the drive has been organized to catch that particular bird.)

4. When the trappers are almost to the entry it may be advisable to move in quickly to push the birds in the entry well into the trap. The two outer trappers might move in slightly ahead of the others and stand near the end of the wing-walls. They may then head-off some birds which otherwise by-pass the trap.

5. The trappers should then move through the catchment area driving the birds before them (a trapper should be assigned to cover each wall as many birds attempt to fly-back along the walls). If the trap has a drop-door one trapper should be ready to drop it when most of the birds are in the "funnel" area. One trapper may be locked in the "funnel" area with the birds and then gently drive them to the catching-box, perhaps catching some by hand. If a bird is fluttering against the glass but not alighting on the treadle the door on the catching-box may be closed by the trapper in the "funnel" area to confine the bird to the catching-box.

6. When all the birds are in the catching-box the trappers may move around to the back of the trap and remove the birds from the catching-box. A number of multi-cell gathering-boxes should be available so that the captured birds may be separated by species, family, or size.

7. After the birds have been removed one trapper should make certain that the drop-door has been raised, the door on the catching-box is open, and the shutter or sleeve on the catching-box is closed.

8. The trappers should then leave the area, either continuing on to drive another trap or going back to band the birds. The trappers should leave the area by the back of the trap, otherwise they may disturb any birds which are in the area in front of the trap.

DISCUSSION

In a paper published in *Bird Banding*, Bergstrom and Drury (1956) reviewed trapping methods as a means of sampling migration, and commented: "We do not know of any full-scale Heligoland traps in use on this side of the Atlantic, and it is unlikely that any will be built as an alternative to mist-nets." In our experience this represents the prevailing opinion among North American banders, and it is therefore necessary to decide whether Heligoland traps do in fact have any application as a means of sampling migration in North America.

In order to evaluate the relative merits of traps and nets it is necessary to refer to the experience of trappers who have used both techniques, and although expense is an important consideration, their efficiency in operation is of primary importance. The coastal bird observatories in Europe have used Heligoland traps for many years, and the recent introduction of nets on a large scale has not curtailed their use as the most productive trapping method of these stations. Indeed, in some locations nets are considered to have a rather limited application. Williamson (1957), in a paper stimulated by the remarks of Bergstrom and Drury, states that "Fair Isle is too wet, windy and bare to promise notable success with Japanese mist-nets. In these

respects it may prove similar to other exposed offshore islands in Europe and North America, particularly as the big falls of migrants at such places are often associated with low pressure weather in which mist-nets cannot be used." Williamson regards nets as a useful ancillary to the permanent traps at Fair Isle.

The present position in the British Isles has been summarized by Spencer (1959) as follows: "At the observatories, Heligoland traps have continued to dominate the scene, as many as ten being in use at a single observatory, and with their aid over 600 warblers have been caught in a day at one station. . . . The mist-net, by its mobility and versatility, has done much to make each ringer a mobile bird-observatory, but this very success has tended to attract man-power from the main observatories, thereby endangering the continuity of effort. This is to be regretted insofar as it is often impossible to see in its proper context a bird caught in a local bramble-patch in the way that a migrant caught at a regularly manned site can frequently be related to a particular movement. On the other hand there is much to be said for the more extensive cover made possible by mist-nets." In North America the wide-spread use of mist-nets has stimulated the founding of a number of coastal stations, particularly those taking part in Operation Recovery (Baird, *et al*, 1958). This does not alter the fact that Heligoland traps are more efficient in dealing with large waves of migrants.

Woodford (1959) has outlined some of the advantages and disadvantages of Heligoland traps and mist-nets based on the use of a trap and nets at Point Pelee. Although Point Pelee is a much less exposed situation than Fair Isle, the results indicated that Williamson was correct in concluding that conditions at coastal stations in North America would prove to be essentially similar to those at Fair Isle. Experience at Long Point (Hussell and Woodford, 1961) has reinforced this conclusion, and a detailed comparison of catches by the two methods has shown that the trap at Long Point has a distinct advantage over nets in dealing with large falls of migrants. This is probably one of the more important advantages of Heligoland traps since the study of the occurrence of large waves of migrants is usually a major concern of coastal stations, and therefore careful consideration should be given to the most efficient method of sampling the migration, so that both an adequate sample may be trapped and sufficient time left for other important activities, such as taking weights and measurements of trapped birds and making sight observations of the migration in progress.

Heligoland traps require an outlay of effort, money and time beyond the resources of most individual banders. They are best built at places where the results will justify the initial investment. Permanent or semi-permanent stations, such as those taking part in Operation Recovery, and established with the definite object of compiling information over a number of years about the migration at a particular location, might make good use of them.

In the long run Heligoland traps may prove to be less expensive than mist-nets. The initial cost of materials in an average sized Heligoland trap would be in the vicinity of $200.00, and provided they are built and maintained properly they will last for years. Costs may be reduced

somewhat by using salvaged materials whenever possible. The average net lasts no more than one season, and soon develops some holes, no matter how careful a bander may be. At about $2.50 per net it does not take long to spend on nets the price of materials necessary for a trap. An interesting point is that, unlike mist-nets, a trap has the same "catching-potential" throughout the season.

When a station is to be manned by volunteers it will be necessary to be sure that enough are available to keep the traps operating over a reasonable proportion of the migration period. For this reason, and also because of the expense involved in building traps, such stations usually have to be operated on a cooperative basis. Building a Heligoland trap is not too formidable a task if a number of volunteers are available. At Long Point four men gathered the material and put up the framework for a full-size trap in a weekend. Covering the framework with wire netting is more time consuming. Probably two or three men could build a complete Heligoland trap in about a week, although it is usually possible to get a trap into a workable condition in a much shorter time.

When a co-operatively manned station, using Heligoland traps and mist-nets, is established it will be found convenient to have a series of bands assigned to the station, rather than having individual banders use their personal bands. Records for the station will then be kept centrally and be readily available for analysis. In Ontario this has not proved to be an obstacle to finding sufficient experienced banders to man the stations at Long Point and Point Pelee.

ACKNOWLEDGMENTS

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ARTIFICIAL INCUBATION OF EGGS OF VARIOUS BIRD SPECIES AND SOME ATTRIBUTES OF NEONATES

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Introduction. In connection with a study of the morphology of just-hatched birds we have accumulated collateral data that may be of some general value to ornithologists. More than 2,000 specimens of 83 species were hatched in incubators. No species tried in adequate samples failed to be amenable to artificial incubation. Incubation data determined in the laboratory where conditions can be standardized are basic to an understanding of the biological problems of natural incubation studied by ecologists.

Evans (1891 and 1892) in Scotland and Heinroth (1908 and 1922) in Germany first and most extensively hatched out Old World species. Baldwin and Kendeigh (1932), Kendeigh (1940), and Graber (1955) investigated artificial incubation of wild birds' eggs in America. Present manuscript was completed in 1957.

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Dr. Richard Graber kindly contributed several specimens hatched in his incubator. Incubators were made available by Dr. Rudolph F. Nunnemacher at Worcester, Massachusetts, Dr. Bradley M. Patten at Ann Arbor, Michigan, Dr. Hugh Clark at Storrs, Connecticut, and the late Dr. Charles S. Johnson at Nashville, Tennessee. Dr. Oliver L. Austin, Jr. and others kindly made many suggestions that were adopted in improving the manuscript; responsibility for the accuracy and organization of the final draft however is entirely our own.

Methods. All the eggs of each clutch found were collected, whether or not the clutch was complete. Date, time, locality, number of eggs in the clutch, degree of certainty of species identification, and data on the incubation attendance of the parent were recorded. A separate data sheet for each egg was kept. At the incubator a clutch- and egg-number was brushed on each egg. The length of time and conditions of transportation from the field were recorded. Each egg was measured or weighed, put in water to determine buoyancy, and candled before being put into the incubator. Efforts were made over the 6-year period to obtain as many eggs as possible.

Artificial incubation was aimed at 37.8°C. and 64 percent relative humidity. Most of the eggs were incubated in forced draft, 600-chicken-egg capacity, American-Lincoln cabinets. The eggs, rolled twice daily, were held in open, partitioned petri dishes lined with gauze. To determine volumes, most of the eggs were weighed daily until they reached specific gravity of unity as determined by buoyancy in water at 37°C. At this point egg weights in grams equal their volumes in cubic centimeters. The comparison of volumes is more significant than comparison of weights of fresh eggs (or at least is more amenable to standardization) because for practical purposes there is no such thing as a "fresh egg" in nature. Balances could be read to at least four digits and were sensitive to at least three decimal places. Thin-shelled eggs, such as those of swallows, were dried completely by blotters before being returned to the incubator. When volumes were not determined in the manner just described most other eggs were measured to greatest length and width by vernier calipers.

Infertile and addled eggs were discarded as soon as detected. Dead embryos were examined for anomalies. The times of first peeping from the egg and of the first pipping of the shell were noted. Efforts were made to preserve the hatchling at, or as near the moment of, hatching as possible, as this was critical to the central study (Wetherbee, 1959). This time was recorded as plus or minus the nearest hour, one-half the interim between incubator tendings. The partitions of the petri dishes isolated each "altricial" chick and its numbered shell from other hatchings; with "precocial" (in the strict ornithological sense) species each egg was individually bagged.

Each chick was weighed, described as to behavior, color of skin, mouth-lining and down, and often compared to other species hatched simultaneously. Each chick was labelled, tied in a gauze bag, and preserved in 10 percent neutral formalin or 75 percent ethyl alcohol. Specimens were later transferred to 95 percent alcohol in individual snap-cap vials. The shells were collected and put into dry storage for reference in case of curatorial errors. This work attempts to establish

a standard for data on incubation under standardized conditions. Such measurements may allow for more accurate and more significant interspecific comparisons, for there should be (ideally) very little intraspecific variation. Embryological development and incubation periods in the wild, however, vary greatly as parental attentiveness, environmental temperature, moisture, etc. are conditions which cannot be measured accurately.

Definitions of terms. Incubation period is defined as the longest time it takes any egg of the given species to hatch spontaneously under artificial incubation in forced air incubator aimed at 37.8°C., 64 percent relative humidity. Such standardization is necessary, because, as every commercial hatcher knows, embryological development is sensitive to slight differences in temperature or humidity (Huggins, 1941). Ideally, experimental work may some day establish the optimum temperature for incubation of each species (Baldwin and Kendeigh, 1932, and Graber, 1955). Incubation periods given here are the longest that we recorded and are not necessarily entire maximum potential incubation periods, though most are probably representative. Incubation period data were not used when the chick required aid in emerging from the shell. Egg clutches of larger species had greater variability in total emergence than egg clutches of smaller species. Mortality statistics for artificial incubation have no bearing on incubation mortality rate in the wild.

The expression of temperature in 0.1°C. rather than 1.°F. is advocated in the interests of establishing a standard of high critical rigor sorely needed for comparative purposes in this type of ornithological work. We have purposely expressed time duration in hours rather than days-and-hours. We believe that the sad state in which the literature of incubation finds itself can be rectified if ornithologists will use consistently the primary units of temporal embryology—hours. Even when we made a conscious effort to record to the nearest hour we often came up with a hatching time "plus or minus 10 hr."; we can't help but wonder what the margins of error are in statements in the literature recorded and expressed in days. What is worse, ornithologists often get confused as to whether or not to count the first day; or they limit the meaning of day to calendar day; or they record incubation time in days and estimated fractions, then later convert to hours.

Interim between hatchings. As eggs may undergo some development in the nest due to variable, warm environmental temperature, even though the eggs are not incubated by the parent, the interim between hatching used as an indication of the relative time of the onset of parental incubation is of most value when expressed as the minimum interim observed in several complete clutches all of which hatch, rather than as the maximum interim.

Clutch weight. Clutch weights were reported only from actual clutches known to be complete by virtue of a hatching time in the incubator considerably less than known incubation periods. These data should be distinguished from clutch weights determined from calculations and extrapolations.

Weights. Averages were determined from segregated clutch averages,

not arithmetic summation of individuals, unless otherwise stated in the text. Neonatal weights were taken of specimens that had just dried, after being taken directly from the constant humidity of the incubator. Many chicks were observed to defecate after hatching; this probably accounts for most disparities between volume of egg and neonatal weight within a species.

Data.

Green Heron *Butorides virescens.* A complete clutch of 5 eggs weighed 80.39 g. 3 days before hatching; these eggs av. 39.3 mm. x 28.7 mm. and 16.08 g. (15.47 g. to 16.73 g.). The chicks at hatching av. 13.05 g. (12.66 g. to 13.55 g.). The 5 hatched a total of 72± 20 hr. apart. Skin was tawny, bill was tipped gray, eyes were open and light olive, down was gray above and white below.

Black-crowned Night Heron *Nycticorax nycticorax.* A complete clutch of 3 eggs weighed 111.2 g. 5 days before hatching; av. 52.3 mm. x 37.8 mm. and 37.06 g. (35.18 g. to 39.33 g.). Another nearly fresh clutch of 3 eggs weighed 104.53 g.; av. 34.84 g. (34.34 g. to 35.26 g.). Dimensions av. 52.5 mm x 34.6 mm. The embryos showed that natural incubation commenced with the laying of the first egg. Av. clutch wt. was 107.9 g., av. egg wt. 35.95 g. Pectination was not in evidence on the toenail at hatching.

American Bittern *Botaurus lentiginosus.* Two chicks from a complete clutch of 3 hatched 44 ± 15 hr. apart. The hatchling's loose skin was pink with a yellowish epidermis, bill flesh color with black tip, mouth light pink, eyes open and light olive, down yellowish olive slightly darker above. They uttered low harsh squawks and sometimes reached out to gape; the lower mandible was soft and spread laterally when opened. The chicks clutched and released with their toes independent of leg movements. Attempts at sitting and raising the head were feeble. The apical digit of the wing was noticeable.

Wood Duck *Aix sponsa.* A complete clutch of 9 eggs weighed 315.7 g. 16 days before hatching. These av. 35.08 g (31.90 g. to 38.55 g.). Four ducklings hatched a total of 27 ± 2 hr. apart and av. 23.53 g. (21.55 g to 25.66 g.). Respiration rate of one at incubator temperature was 42 times per minute. When one was put in water it tried to swim but sank and drowned. The down was sheathed for some hours after hatching, the rectrices (or their coverts?) were decurved, perhaps to hold an air bubble for greater buoyancy. We found no particularly developed nail at the tip of the bill, although such an aid to climbing from the nesting cavity has frequently been ascribed in Forbush's and Kortright's standard works. The legs and feet were black except for a cream stripe down lateral side of leg and on areas between joints; upper mandible black except for cream tip, egg-tooth tan, lower mandible cream, iris olive. The natal down freed of its investing sheathes was blackish olive above and buffy yellow below; no loral stripe was present, the facial markings surrounded a cream cheek patch. The texture of the down was coarse; the tips of barbs on upper parts were elongate and smooth like mammalian guard hairs.

Black Vulture *Coragyps atratus.* A complete clutch of 2 eggs weighed 196.5 g. 2 days before hatching; these eggs av. 81.0 mm. x 51.8 mm. and weighed 96.54 g. and 100.0 g. The chicks at hatching weighed 75 ± 7 g. and hatched 16.6 hr. apart. Dark gray down 10 mm. long covered the body except the mid-ventral apterium and the blackish-gray face. Behind the olive open eye was a crescent of 1 mm. natal down. The pale gray legs and feet were thick and fleshy, reminescent of the oedema-like swelling of neonatal flamingos as described by Barruel (1954). The chicks stood weakly, trembled and uttered soft hissing noises. Their tongues were curious, thin, trough-like folds, opening when protruded and closing when withdrawn.

Red-shouldered Hawk *Buteo lineatus.* The bill of the chick was black, contrasting with the light color of cere; toe nails gray. The natal down, 10 to 15 mm. long was at first completely sheathed as in other hawks, but soon fluffed

out to cover the body with light buffy brown plumage, darkest on the scapular and alar tracts.

Broad-winged Hawk *Buteo platypterus*. One egg, advanced in incubation when received, weighed 40.60 g. 22 days before hatching, had a volume of 39.17 cc., and reached 1.0 sp. gr. 16 days before hatching; neonatal wt. 29.63 g. The chick cheeped continually and was covered with short, dirty white down; bill was black, cere flesh-colored, talons gray. Its eyes were closed and the feet apparently could not grip.

Sparrow Hawk *Falco sparverius*. Three eggs from a complete set of 5 av. 14.93 g. 6 days before hatching. Two of the 5 that hatched weighed 11.37 g. and 12.30 g. and hatched a total of 60 ± 5 hr. apart. The chick was as helpless as a neonatal songbird, with pink skin and silvery white down covering all the body. The eyes were open, especially when the bird whined or gaped. Unlike the neonatal Broad-winged Hawk these chicks could grasp with their feet. The notch and tooth characteristic of the genus was already developed at hatching.

Ruffed Grouse *Bonasa umbellus*. Typical egg wt. from a complete clutch of 13 was 14.45 g. 7 days before hatching. Nine that hatched av. 13.98 g. (11.46 to 16.48 g.). These hatched over an interim of 9 ± 6 hr. apart. One that hatched in 534 ± 8 hr. from an incomplete clutch of 8 weighed 17.60 g. as a fresh egg, 14.36 g. the day before hatching, and 12.26 g. as a neonate. The black eyes were open, bill and weak legs pinkish yellow. The flight feathers were remarkably developed. The chicks uttered notes of 4 syllables. The down, finely variegated on the upper parts with buffy yellow, golden brown and black was buffy yellow on the underparts and extended down each side of the tarso-metatarsus. The culmen lacked the black mark of the Greater Prairie Chicken and the black ear-stripe was more prominent but the black of the variegation was much less extensive.

Greater Prairie Chicken *Tympanuchus cupido*. The cream bill of the chick was black on the culmen. Down extended the length of the legs even onto the toes. The upper parts were variegated buffy yellow, black and brownish red; the face and under parts tawny. Four black spots behind the eye and about the ear were noticeable. The quills of the primaries were well started.

Bobwhite *Colinus virginianus*. Seven fresh eggs (from penned birds) av. 31.5 mm. x 24.8 mm. and 10.32 g. (9.50 g. to 11.29 g.). The neonates hatched at 559 ± 7 hr. and av. 7.52 g. (6.77 g. to 8.60 g.). Six eggs each of the blonde and Red Tennessee breeds did not differ significantly in any of these characters. The down was striped chestnut, buffy yellow and blackish-brown. On the back were 2 buffy yellow stripes, not 3 stripes as in Gambel's Quail and California Quail. There was a black stripe over the ear, the underparts were light gray.

California Quail *Lophortyx californicus*. Six fresh eggs (from penned birds) av. 30.7 mm. x 23.5 mm. and 8.55 g. (8.07 to 9.50 g.). Incubation lasted 559 ± 7 hr.; 2 chicks weighed 6.28 g and 7:00 g. The plumage was like that of the Bobwhite except for 3 buffy stripes on the back.

Gambel's Quail *Lophortyx gambelii*. Six fresh eggs (from penned birds) av. 29.9 mm. x 24.5 mm. and 9.66 g. (9.00 g. to 10.34 g.). Incubation lasted 559 ± 7 hr.; 3 chicks ranged from 6.67 g. to 8:00 g. We could not distinguish this species from California Quail in natal plumage.

Common Coturnix *Coturnix coturnix*. Eight fresh eggs (from penned Japanese birds) av. 32.0 mm. x 24.9 mm. and 10.68 g. (9.47 g. to 12.16 g.). Incubation periods were puzzlingly variable. Fifty fresh eggs received in February took 460 ± 0 hr., in March 414 ± 5 hr., and 100 in July 395 ± 15 hr.; the latter was nearest the claims of commercial breeders. Three of these incredibly prolific birds with such short incubation periods commenced laying unfertilized eggs themselves in my pens at 4 weeks (April 10, 1957) of age. Neonatal wt. of 6 chicks av. 8.03 g. (7.05 g. to 8.90 g.).

Ring-necked Pheasant *Phasianus colchicus.* Twelve fresh eggs av. 32.47 g. (30.06 g. to 35.56 g.). Nine of these av. 46.7 mm. x 36.8 mm.; 4 had vol. 27.93 cc. to 30.17 cc., and reached 1.0 sp. gr. 9 to 15 days before hatching. The longest incubation recorded was 550 ± 0 hr. Neonatal wt. of 5 chicks av. 23.28 g. (20.91 g. to 25.40 g.). The culmen was dark gray, the bill, legs and feet were cream. The down was indistinctly striped blackish brown and buffy brown, the underparts were buffy yellow, there was a black spot in front and behind each ear. Down did not extend onto the legs, as it did in the Ruffed Grouse.

Red Jungle Fowl *Gallus gallus.* Eighteen fresh eggs av. 51.1 mm. x 36.8 mm. had av. wt. 37.54 g. (31.05 g. to 40.02 g.). Ten of these eggs produced chicks with av. wt. 26.01 g. (21.28 g. to 29.70 g.). The incubation lasted 504 ± 0 hr. Three "large" eggs of the common chicken, Columbian breed, av. vol. 48.41 cc. produced chicks 37.15 g. av. wt.

Virginia Rail *Rallus limicola.* Two eggs from a complete clutch of 10 weighed 8.51 g. and 8.53 g. 5 days before hatching. Four that were allowed to hatch av. 5.58 g. neonatal wt. and emerged within 11 hr. of each other. The chick, unable to stand, was a pitiful looking thing, quivering and raking its long witch-like digits as a barnacle combing the water. It explored crevices with its black-tipped bill and made feeding movements with the bill and throat. While the eyes were already developed enough to open occasionally, they were kept closed for the most part. The alula seemed inordinately long, the occiput bulged as in "altricial" young. The natal down was black, but 2 chicks of the 5 had a patch of white down below the wings suggestive of a species-dimorphism.

Killdeer *Charadrius vociferus.* A complete clutch of 4 eggs weighed 46.42 g. 3 days before hatching with av. wt. 11.61 g. (11.19 g. to 12.09 g.). The neonates av. 9.29 (9.03 g to 9.68 g.). These eggs hatched a total of 0 ± 7 hr. apart. Another fresh clutch of 4 eggs, probably complete, weighed 55.48 g. 15 days before hatching, with the av. 13.87 g. (14.30 g. to 13.00 g.) Av. dimensions were 39.5 mm. x 27.4 mm. The neonates av. 10.49 g. (10.30 g. to 10.74 g.). The chicks emerged a total of 22 ± 11 hr. apart. The clutches av. 50.59 g. total wt., 12.74 g. egg wt., and 9.89 g. neonatal wt. Color of soft parts: iris olive, bill black except light tips, feet and legs light straw yellow with poorly defined gray zones at joints, toe nails black, skin of apteria and of the wings buffy brown. The pattern of the down was accented by jet black borders between the pure white areas and velvet-like brown areas; it was most strikingly conspicuous as a black ring around the neck. Down of the frontal region, throat and nape-ring, distal wing segments and all of under-wing areas and underparts was white. Crown, infra-orbital stripe and dorsum, olive with black mid-dorsal patch. The short olive tufts (3 to 5 mm.) of the upper parts had longer black tips presenting an exquisite plush. The downs of the upper tail-coverts were 10 to 15 mm. long and banded black and buffy yellow; the rectrices fully 40 mm. long were black and like a tuft of cut pile. The white of the under parts was suffused tawny about the femoral region and under tail-coverts.

American Woodcock *Philohela minor.* A complete clutch of 3 eggs weighed 46.63 g. 2 days before hatching, av. 15.5 g. egg wt. (12.16 g. to 17.56 g.). The chick from the smallest egg had trouble hatching, the membranes dried in the pipped shell and part of the yolk-sac did not retract. The other 2 hatched 0 ± 5 h. apart and weighed 13.06 g. and 13.13 g. They squatted, uttered slight peeps, walked with poor balance and had their eyes open. At hatching the woodcock already had the bill shaped like a blunt probe and the robust toes were longer than either of the leg segments. The spine of the thoracic vertebrae was peculiarly hunched. This species did not have the long tail characteristic of the Killdeer and Spotted Sandpiper. The down was not dense and was golden blackish brown alternating in stripes of tawny yellow.

Spotted Sandpiper *Actitis macularia.* The skin was very dark, becoming lighter with spots on the tibio-tarsus and fading out on the absurdly long legs and feet. The down of the upper parts was golden brown and black, under parts white save a black patch on the lower neck. A prominent black line in front of the eye. The long tail was like a tuft of cut pile and patterned a fine black and golden agouti.

Herring Gull *Larus argentatus.* Four neonatal chicks av. 60.6 g. (52.3 g. to 67.7 g.). The physical strength of these eggs was incredible; addled eggs built up tremendous gas pressure which was ultimately released by explosion. The mandibles were buffy brown with smoke gray tips; legs, feet and toe nails were buffy brown. The down was at first completely sheathed (as in many other birds), but later fluffed out to form a long dense nap with the texture of beaver fur. The pattern of alternation of buff and blackish brown areas was complexly variegated with tawny suffusion over the fore.

Common Tern *Sterna hirundo.* Two eggs av. 18.86 g. 12 days before hatching, had vol. 21.41 cc. and 17.66 cc. and reached 1.0 sp. gr. 11 days before hatching. Five neonates av. 12.09 g. (10.67 g to 13.58 g.). The mandibles were black tipped, the down of the upper parts was variegated light tawny and black, the tawny predominating and the underparts were white save the chin and throat which were blackish brown.

Rock Dove *Columba livia.* Five eggs from 5 clutches of feral doves av. 16.87 g. (15.18 g. to 18.76 g.), and 39.5 mm. x 28.7 mm. Five neonatal squabs av. 12.22 g. (11.02 g. to 13.30 g.). Very pale gray wooly down 15 mm. long sparsely covered the body but was noticeably absent over the ventral apterium and face. Skin light, in contrast to that of Mourning Dove. Prognathous, tips of mandibles white, bill relatively long, longer than head, with bulging nasal shields. The huge eyes still-closed showed dark bluish through the skin and projected over the crown like those of a frog. An egg from a loft of a large white breed of unknown identity weighed 22.09 g., vol. 21.15 cc., reached 1.0 sp. gr. 9 days before hatching, had an incubation period 414 ± 5 hr. and produced a neonatal squab weighing 15.2 g.

Mourning Dove *Zenaidura macroura.* A complete clutch of 2 eggs weighed 15.03 g. 11 days before hatching, egg wt. 7.80 and 7.23 g., neonatal wt. 5.35 g. and 4.95 g. These hatched 27 ± 2 hr. apart, commensurate with the observed differences in development of the very early candled embryos. Respiration rate at incubation temp. was 72 times per minute. They uttered a faint weep. The buffy yellow down was wooly in texture; it covered the chick except the ventral apterium, legs and feet, lower eyelid, ear and chin. The skin of the helpless squab was olive, like a rotten fruit, the closed eyes showed black through the skin; the bill was black except for the swollen region at the nares and at the tips in front of the egg teeth; the mouth was the same color as the bill externally. A very large crop was noticed.

Domestic Parakeet *Melopsittacus undulatus.* Ten fresh eggs from the same hen av. 2.39 g. (2.07 g. to 2.54 g.) and 18.0 mm. x 15.7 mm. Neonatal wt. of 3 ranged from 1.65 to 1.70 g. Incubation periods were 405 ± 4 hr. The hen started incubation immediately after the first egg was laid. Except for a white chenille down 1 to 2 mm. long over the dorsum lateral to the broad ephippial apterium, the chicks were bare. The cere and the embryo-like overshot upper jaw, retained in the adult, and yoke-toes were already in evidence. The upper neck muscles were enormously developed.

Common Nighthawk *Chordeiles minor.* A complete clutch of 2 partly incubated eggs, characteristically covered with a powdery bloom, was artificially incubated for 11 days; 65 hr. after the first chick had hatched, the second was taken alive from a pipped shell. The upper parts were variegated black and buffy yellow; the under parts pale gray. The down covering the body was shaggy but rather thin on the dorsum. The shaggy longer down of the head and throat obscured the shape of the chick. The external nares, situated near the tip of the bill, were flared like those of a goldfish.

Black-billed Cuckoo *Coccyzus erythrophthalmus.* Two nestlings about 3 days old had 10 symmetrically arranged pustules on the roof of the mouth and on the tongue, "guide marks for parental feeding" of some authors. The tongue was edged with black at its tip. This species and three passerines: Catbird, Horned Lark and Blue-gray Gnatcatcher were the only North American birds noted to have actual markings in the mouth. We have seen African weaver finches

among the spirit collections of museums that have this trait elaborately developed with markings having a metallic luster. The legs, feet and bill were slate-blue.

Great Horned Owl *Bubo virginianus*. Down on a just-hatched bird was white and fluffy over the entire body, including the toes. The bill and toe nails were dark olive.

Ruby-throated Hummingbird *Archilochus colubris*. Two chicks, naturally incubated, were noted to hatch 17 ± 17 hr. apart. The skin was pigmented dark gray, contrasting with the buffy yellow down. The distended crop was full of small spiders, their first food. The chick's toe nails seemed disproportionately long.

Belted Kingfisher *Megaceryle alcyon*. A complete clutch of 8 eggs was brought through the last 10 days of incubation. The neonates weighed an av. 9.33 g. (8.46 g. to 10.36 g.), and hatched a total of 33 ± 4 hr. apart. The chick was duck-like and without down and with pink skin through which the vertebrae showed clearly. It walked hunched. Although its eyes were still closed, they could be forced open. The chicks were positively thigmotropic, and when two came in contact they seemed to lock necks by contact stimulus. They stood on feet and heels without touching the abdomen as they uttered cheeps; they did not gape. The prognathous bill was black without the rictal swellings of cavity-nesting passerines, the mouth lining was flesh-color. The alular claw was conspicuously white, toe nails gray.

Yellow-shafted Flicker *Colaptes auratus*. Six neonates from a heavily incubated, complete clutch of 8 eggs av. 4.80 g. (4.20 g. to 5.12 g.) and hatched a total of 7 ± 5 hr. apart. Of the remaining 2 eggs, 1, rather larger than the rest, seemed to be infertile while the other, a runt (5.81 g.), was just showing embryonic development when the clutch was hatching, but it soon died. Another clutch had the following history: one egg was always left in the nest and the others removed on the day of laying. Eggs *a*, *b*, *c*, *d*, and *e* were laid on successive days; then 2 days elapsed before egg *f* was laid; then 2 more eggless days elapsed before *g* and *h* were laid on successive days; 2 more eggless days elapsed before *i*, a small egg with marbled texture was laid. The female attended the nest 5 more days before she and the egg disappeared. The eggs of this clutch av. 7.21 g., none was successfully incubated by us. These observations seem to contradict the indeterminate-laying reputation of this species. Another complete clutch of 4 eggs av. 28.5 mm x 22.9 mm. and hatched a total of 8 ± 6 hr. apart. The flesh-colored chicks were without natal down and without contrasting color of the mouth lining. The rictal flanges of the strongly prognathous mandible were curiously situated on the sides of the lower mandible, not at the angle of the jaw. A probable epigenetic significance of this fact is that the lower mandible is indeed prognathous in an absolute sense. Another strange feature of these reptile-like hatchlings was the swollen heel pads covered with friction ridges of papillae. The external auditory meatus was oblique to the surface of the head and was difficult to see, giving the erroneous impression that woodpeckers have no ears at hatching.

Downy Woodpecker *Dendrocopos pubescens*. A complete clutch of 4 eggs weighed 8.32 g. 4 days before hatching; the eggs av. 2.08 g. (1.95 g. and 2.22 g.). The neonates av. 1.67 g. (1.55 g. to 1.77 g.) and hatched a total of 5 ± 3 hr. apart. The naked, prognathous pinkish chicks rendered a chattering call not unlike that of an adult Barn Swallow and also a higher pitched, short peep. The open mouths were without special coloration and like the flicker, the heels had friction pads.

Eastern Kingbird *Tyrannus tyrannus*. A complete clutch of 3 eggs weighed 10.10 g. 13 days before hatching; the eggs av. 3.37 g. (3.21 g. to 3.54 g.), had av. vol. 3.27 cc. (3.13 cc. to 3.41 cc.), and reached 1.0 sp. gr. 11 days before hatching. The hatchlings weighed 2.43 g. each and emerged a total of 0± 5 hr. apart. Another egg constituting a complete clutch in itself was a giant that weighed 4.71 g. 11 days before hatching. The egg was left undisturbed in the

nest for 2 days after discovery and the nest checked again 2 days after our robbery to determine whether more would be laid. It remained the only egg. Its vol. was 4.40 cc. and it did not reach 1.0 sp. gr. until the day before hatching out a 3.71 g. chick. Some natural incubation obviously had taken place in the nest as it hatched in our incubator after only 265 ± 2 hr. Length of incubation period in chickens is not affected by wt. of egg according to Hays (1941), but "each increase of one gram in egg wt. delayed hatching 3.73 minutes" in chickens (D. W. MacLaury, pers. comm.). A third clutch of 4 eggs that was probably complete and nearly fresh had av. dimensions 23.1 mm. x 16.4 mm. and hatched a total of 13 ± 7 hr. apart, with an incubation period of 366 ± 7 hr. The skin and mouth of the chick were orange-yellow, the down white.

Eastern Phoebe *Sayornis phoebe*. Av. complete clutch wt. of 5 clutches was 9.04 g. (9.90 g. for a clutch of 5 eggs 8 days before hatching and 7.68 g. for a clutch of 4 eggs 10 days before hatching). Av. egg wt. per clutch in 11 clutches was 2.06 g. (1.86 g. to 2.27 g.). Thirty-four individual eggs ranged from 1.75 g. to 2.38 g. Av. egg vol. per clutch in 7 clutches was 2.03 cc. (1.86 cc. to 2.21 cc.). Eighteen individual eggs ranged from 1.75 cc. to 2.29 cc. Most eggs reached 1.0 sp. gr. 9 days before hatching. Av. neonatal wt. per clutch in 12 clutches was 1.50 g. (1.29 g. to 1.88 g.). Thirty-three individual chicks ranged from 1.25 g. to 1.88 g. Longest incubation period was 375 ± 0 hr. Several other eggs closely approached this time and it is believed to be representative. In 4 clutches in which all eggs hatched, the maximum time for total clutch emergence was 11 ± 0 hr. In a clutch in which 3 or 4 hatched, the 3 emerged a total of 0 ± 4 hr. apart. As that clutch was transported more than a hundred miles the day before hatching this may have caused the relatively synchronous hatching. In one clutch that contained a cowbird's egg 2 of 4 chicks that hatched emerged a total of 32 ± 5 hr. apart, not considering the parasite. Our interpretation is that the phoebe was stimulated to commence incubation early when the cowbird's egg completed her stimulus threshold number. It is noteworthy that she laid the additional egg nevertheless. Two phoebe eggs substituted in a Tree Swallow nest failed to hatch. The flesh-colored neonate had medium gray down above and white below and had yellow bill, mouth, feet and posterior parts. The long toe nails were gray, the yellow rictal region was only slightly flanged. Heads of neonatal flycatchers were noted to be fully as large as the bodies.

Great Crested Flycatcher *Myiarchus crinitus*. A nestful of 6 recently hatched young showed noticeable differences in size (probably because of age). The down was dark gray becoming lighter gray on the alar and femoral pterylae; the body was dark flesh color; the mouth lining was dull orange-yellow and the relatively broad rictal flanges were cream.

Least Flycatcher *Empidonax minimus*. Two fresh eggs measuring 16.0 mm. x 13.0 mm. hatched in 322 ± 5 hr. The chicks had very small yellow mouths without rictal flanges and their down was light gray. Another nest in which the first egg was laid June 2 and the second egg June 3 (or June 4) had no additional egg June 5, when the 2 were taken and 2 Tree Swallow's eggs put in their place. On June 6 the swallow's eggs had disappeared. The artificially incubated Least Flycatcher eggs died during early development.

Horned Lark *Eremophila alpestris*. A probably incomplete clutch of 3 eggs av. 2.75 g. (2.49 g. to 2.89 g.). These had av. vol. 2.63 cc. (2.35 cc. to 2.78 cc.). They reached 1.0 sp. gr. 7 days before hatching. Neonatal wt. of 2 chicks was 1.70 g. from the smallest egg and 2.47 g. from the largest. Their incubation was 253 ± 4 hr. while in our cabinet. The chicks' skins were black above, but orange below; the down was buffy yellow. The inside of the mouth was orange, especially the median part, with arresting black mouth markings distributed as follows: a spot on the inside tip of the upper and of the lower mandibles, one at the tip of the tongue and a spot at each posterio-lateral corner of the tongue. The rictus was light yellow.

Tree Swallow *Iridoprocne bicolor*. Our data on this species cannot be analysed by clutches because our early techniques were inadequate. Av. egg wt. of 26 eggs was 1.80 g. (1.54 g. and 2.28 g.); av. vol. of 20 eggs was 1.72 cc. (1.50 cc.

to 1.96 cc.); they reached 1.0 sp. gr. 7 days before hatching. Neonatal wt. of 18 chicks av. 1.34 g. (1.08 g. to 1.55 g.). The longest incubation periods recorded were 346 ± 0 hr. and 340 ± 0 hr. In 2 cases that were checked the hen laid a fifth egg the day after the incomplete clutch of 4 was robbed. One hen laid a fifth egg, after the first 3 and the fourth egg had been robbed on successive days. We planted Tree Swallow eggs in an Eastern Phoebe's nest and also in a Barn Swallow's nest successfully; the foster parents hatched and fledged the young swallows. All species of swallows in the neonatal condition were noted to have a pallor compared to young of species of other groups. Tree Swallows compared to Bank Swallows were larger and lighter (not so pink) in skin color; the mandibles lacked the gray tip; the hatchlings were more lethargic; the mouth was very pale yellow, not flesh-color; the swollen, white rictal flanges contrasted with the narrower flesh-color flanges of the Bank Swallow. Tree Swallows compared to Barn Swallows were of about equal size but lighter in color, the mouth less yellow, down whiter and rictal flanges swollen to form more of a sigmoid outline. The latter observation may be a demonstration of the utility of the flanges in cavity nesters.

Bank Swallow *Riparia riparia.* Av. complete clutch wt. of 2 clutches was 7.79 g. (7.57 g. for a clutch of 5 eggs 6 days before hatching, and 8.02 g. for a clutch of 6 eggs 9 days before hatching. Av. egg wt. per clutch in 8 clutches was 1.47 g. (1.32 g. to 1.64 g.); 37 individual eggs ranged from 1.22 to 1.95 g. Av. egg vol. per clutch in 6 clutches was 1.41 cc. (1.26 cc. to 1.62 cc.); 21 eggs ranged individually from 1.17 cc. to 1.78 cc. They reached 1.0 sp. gr. 7 days before hatching. Av. neonatal wt. per clutch in 5 clutches was 1.04 g. (0.86 g. to 1.16 g.); 18 chicks ranged from 0.79 g. to 1.23 g. None of the clutches was fresh enough to span the entire incubation period in the incubator; however 1 clutch was successfully hatched after 10 days, a gratifying performance for this difficult-to-incubate species. The only complete clutch of 100 percent success was a clutch of 5 eggs that hatched a total of 36 ± 9 hr. apart. Data from less successful clutches support the view that this span is representative of the time elapsing from deposition of the first egg to initiation of incubation. Neonatal Bank Swallows were very active and crawled long distances. Their skin was pink, down light gray, bill gray or black at tip, mouth lining and rictal flanges were light fresh-color, toe nails white. Compared to the Cliff Swallow this species had darker pink skin, a smaller, narrower mouth and rictal flanges, and darker gray down.

Rough-winged Swallow *Stelgidopteryx ruficollis.* Av. egg wt. per clutch in 6 clutches was 1.84 g. (1.60 g. to 2.02 g.); 29 individual eggs ranged from 1.49 to 2.08 g. Av. egg vol. per clutch in these 6 clutches was 1.77 cc. (1.52 cc. to 1.98 cc.); 21 individual eggs ranged from 1.44 cc. to 2.02 cc. The number of days before hatching that eggs reached 1.0 sp. gr. varied from 3 to 10. Av. neonatal wt. per clutch in 3 clutches was 1.29 g. (1.12 g. to 1.56 g.); longest incubation period 367 ± 4 hr. and 366 ± 0 hr. in different clutches. In no clutch did all eggs hatch, but in one in which 2 of 7 hatched the interim between was 36 ± 8 hr. In one instance a sixth cold egg was found in the nest the morning after the first 5 had been removed. All eggs were laid on successive mornings. The neonates crawled as actively as did those of the Bank Swallow. Compared with a Barn Swallow that hatched simultaneously, the Rough-winged Swallow was smaller, had darker tips of the mandibles and had paler rictal flanges.

Barn Swallow *Hirundo rustica.* Av. egg wt. per clutch in 5 clutches 1.95 g. (1.82 g. to 2.16 g.); 16 individual eggs ranged from 1.70 g. to 2.27 g.; av. egg vol. per clutch in these 5 clutches was 1.88 cc. (1.74 cc. to 2.11 cc.); 15 individual eggs ranged from 1.64 cc. to 2.19 cc. Sp. gr. of 1.0 was reached 5 to 9 days before hatching. The extremely thin shells of all species of swallows probably presents for them a delicate problem in water conservation. Longest incubation period was 364 ± 0 hr. with the next closest 358 ± 4 hr. Av. neonatal wt. per clutch in 4 clutches was 1.47 g. (1.39 g. to 1.61 g.); 13 chicks ranged from 1.32 g. to 1.69 g. One complete clutch of 5 eggs hatched over an interim of 48 ± 10 hr. Another clutch with only 4 eggs hatched over an interim of 42 ± 6 h. Barn Swallows seemed very weak on hatching. One pair of Barn

Swallows hatched and raised 2 Tree Swallows which had been experimentally substituted into the clutch. However, in another instance all the eggs including those of the host were found out of the nest the day after introduction.

Cliff Swallow *Petrochelidon pyrrhonota*. Our data on this species cannot be analyzed by clutches because of the inadequacy of our early techniques. Av. individual egg wt. for 18 eggs 2.14 g. (1.89 g. to 2.53 g.); av. individual vol. for these long eggs 2.07 cc. (1.82 cc. to 2.46 cc.); they reached 1.0 sp. gr. on the average 7 days before hatching. Av. individual neonatal wt. of 8 chicks was 1.62 g. (1.45 g. to 1.86 g.). Our longest incubation record 314 ± 0 hr. was undoubtedly short, the egg having gone through some natural incubation before collection. The young were noted to use their heads to butt objects within touching distance; their foot movements seemed to comb at their wings. Their skin was light pink, bill and mouth showed no special coloring, the rictal flanges were pale; down light gray, toe nails white.

Blue Jay *Cyanocitta cristata*. Av. egg wt. per clutch in 4 clutches 6.47 g. (5.95 g. to 7.15 g.); 9 individual eggs ranged from 5.95 g. to 7.38 g. Av. egg vol. per clutch in these 4 clutches was 6.16 cc. (5.66 cc. to 6.76 cc.); individual egg vol. ranged from 5.66 cc. to 6.97 cc. They reached 1.0 sp. gr. on the av. 8 days before hatching. Av. neonatal wt. per clutch in 5 clutches was 4.99 g. (4.70 g. to 4.91 g.); 13 individual chicks ranged from 4.59 g. to 5.28 g. Longest incubation period was 406 ± 0 hr., second longest was 392 ± 5 hr. Parental incubation undoubtedly begins before the clutch is complete for a probably incomplete clutch of 2 eggs hatched 13 ± 5 hr. apart and a complete clutch of 5 eggs, 4 of which hatched, hatched over a span of 44 ± 7 hr. In a nest kept under observation, the third egg was laid between 10 A.M. and 6 P.M. The neonate was without natal down; its back was gray, belly pink; the hooked toe nails white, mouth light salmon. The rictal region had no flanges. The lower mandible was shorter than the upper at least in one specimen.

Common Crow *Corvus brachyrhynchos*. Four eggs from a complete clutch of 5 av. 18.61 g.; 3 of these had av. vol. 18.15 cc. (17.47 cc. to 18.63 cc.). Sp. gr. of 1.0 was reached 11 days before hatching.

Black-capped Chickadee *Parus atricapillus*. The eggs of this species were difficult to bring all the way through the incubation period; those we hatched successfully were collected 5 days before hatching. Av. egg wt. per clutch in 3 clutches 1.20 g. (1.08 g. to 1.27 g.); av. egg vol. per clutch in 2 clutches 1.16 cc., with individual eggs ranging from 1.15 cc. to 1.23 cc. Neonatal wt. of 1 clutch av. 0.85 g. (0.71 g. to 0.93 g.); one from another clutch was 0.70 g. In 1 clutch 6 of 7 eggs hatched successfully over a period of 61 ± 10 hr. One clutch that contained 10 eggs failed to develop; these were covered by nesting material when found. Neonatal chickadees had a glaucous pallor like the young of swallows; their mouths were very pale yellow and the large rictal flanges were white. They uttered pipping sounds, used their wings to aid in crawling, and begged for food very actively.

Carolina Chickadee *Parus carolinensis*. A complete clutch of 5 eggs weighed 4.96 g. the day before hatching; av. egg wt. per clutch in 4 clutches was 1.04 g. (0.96 g. to 1.16 g.); 19 individual eggs ranged from 0.90 g. to 1.21 g. Av. neonatal wt. of 5 chicks from the same clutch 0.79 g. (0.75 g. to 0.86 g.). This clutch hatched 0 ± 10 hr. apart in contrast to the staggered incubation noted in a single clutch of Black-capped Chickadee, however our samples of each species are probably inadequate. The neonates had dark gray down, light yellow mouth and large white rictal flanges.

White-breasted Nuthatch *Sitta carolinensis*. Av. egg wt. per clutch in 2 clutches was 2.23 g. (2.15 g. to 2.31 g.); av. vol. per clutch of these 2.17 cc. (2.03 cc. to 2.31 cc.); 9 individual eggs had vol. 1.86 cc. to 2.34 cc. and reached 1.0 sp. gr. on the av. 8 days before hatching. Av. neonatal wt. per clutch 1.63 g. (1.54 g. to 1.71 g.); 9 individual chicks had wt. 1.52 g. to 1.80 g. Longest incubation period was 351 ± 5 hr., recorded for 3 eggs hatched from a clutch

of 7 eggs that we belived were fresh; these hatched over a span of 0 ± 5 hr. The other clutch, from which 5 of 9 hatched, opened over a span of 46 ± 16 hr. The neonate was light pink but not as light as a just-hatched Tree Swallow. The mouth was cream bordered by a yellow-edged bill and rictal flanges. Some chicks seamed weak and lethargic, others crawled well and uttered peeps.

House Wren *Troglodytes aedon*. Av. egg wt. per clutch in 4 clutches was 1.41 g. (1.06 g. to 1.67 g.); 11 individual eggs ranged from 1.02 g. to 1.71 g. Av. egg vol. per clutch in these 4 clutches 1.44 cc. (1.02 cc. to 1.85 cc.); 11 individual eggs ranged from 0.98 cc. to 1.62 cc. and reached 1.0 sp. gr. 6 to 9 days before hatching. Neonatal wt. of 3 chicks ranged from 1.04 g. to 1.17 g. Longest incubation period for 2 eggs that we believed were fresh and that were from different clutches was 350 ± 5 hr. The skin of the neonate was very dark gray; the legs, feet, and mouth were slightly yellow, the rictal flanges white, down dark gray.

Bewick's Wren *Thryomanes bewickii*. Av. egg wt. per clutch in 2 clutches was 1.36 g. (1.32 g. to 1.40 g.); 11 individual eggs ranged from 1.23 g. to 1.44 g. Av. dimensions, by clutches, were 15.7 mm. x 12.3 mm. Clutch wt. was 9.78 g. 6 days before hatching. Neonatal wt. of 3 chicks (2 clutches) av. 1.11 g. (1.00 g. to 1.15 g.). Longest incubation period was 350 ± 10 hr. for a fresh egg from a probably incomplete clutch of 4 eggs. While Bewick's Wrens' eggs seemed difficult to incubate artificially, a clutch in nature was noted to hatch only 3 of 6; one of these showed no development, another died when about half incubated, and the third died in the pipped shell.

Carolina Wren *Thryothorus ludovicianus*. One complete clutch of 5 eggs weighed 13.64 g. 9 days before hatching. Av. egg wt. was 2.73 g. (2.64 g. to 2.92 g.). Av. dimensions were 2.05 mm. x 1.56 mm. The 3 hatchlings av. 2.09 g. (1.90 g. to 2.20 g.). These 3 emerged over a span of 0 ± 10 hr. The neonates were not darkly pigmented like those of the House Wren. The mouth was yellow, the rictal flanges pale yellow, the bill was tipped with dark gray, the down was dark gray. The neck seemed comparatively thick.

Mockingbird *Mimus polyglottos*. Av. egg wt. per clutch in 3 clutches was 4.60 g. (4.49 g. to 4.69 g.); av. dimensions 24.5 mm. x 18.6 mm.; 6 individual eggs ranged from 4.28 g. to 4.80 g. Av. neonatal wt. per clutch in 2 clutches that were incomplete was 3.50 g.; 5 individual chicks ranged from 3.28 g. to 3.84 g. Longest incubation periods for eggs known to be fresh when collected were 298 ± 9 hr. and 293 ± 10 hr. Neonates were olive with yellow mouths and extremities, the bill was tipped with dark gray. The light yellow rictal flanges were broad, almost as prominent as those of the neonatal Starling (the flange of which is supposed to demonstrate cavity-nesting adaptation).

Catbird *Dumetella carolinensis*. Complete clutch wt. in 2 clutches was 14.61 g. in 1 clutch of 4 eggs 1 day before hatching, and 16.25 g. in another clutch of 4 eggs 7 days before hatching. Av. egg wt. per clutch in 8 clutches was 3.87 g. (3.65 g. to 4.18 g.); 21 individual eggs ranged from 3.40 g. to 4.26 g. Av. egg vol. per clutch in 7 clutches was 3.74 cc. (3.43 cc. to 4.02 cc.); 16 individual eggs ranged from 3.43 cc. to 4.13 cc. They reached 1.0 sp. gr. 7 days before hatching. Av. neonatal wt. per clutch in 9 clutches was 2.85 g. (2.57 g. to 3.17 g.); 24 individual chicks ranged from 2.52 g. to 3.41 g. Longest incubation period for an egg known to be fresh when collected was 317 ± 3 hr.; the next longest 316 ± 5 hr. Shortest interim between total hatch in a clutch of 4 eggs was 12 ± 5 hr.; others were 25 ± 0 hr., 36 ± 5 hr. and in a complete clutch of 3 eggs 33 ± 15 hr. The skin of the neonate was dark gray, similar to that of the House Wren, the down was black, toe nails (variably) and tips of the sharp bill dark gray, mouth yellow, rictal flanges white, and peculiarly, the tip of the tongue was variably black.

Brown Thrasher *Toxostoma rufum*. A neonate weighed 4.70 g. In a complete clutch of 4 eggs 3 hatched over a span of 24 ± 12 hr. The skin was dark gray especially on the dorsum and the down was black; the mouth cream laterally becoming orange in center, rictal flanges white.

Robin *Turdus migratorius*. Av. complete clutch wt. of 4 clutches was 21.20 g. (18.71 g. for a clutch of 3 eggs 8 days before hatching and 23.62 g. for a clutch of 4 eggs 5 days before hatching). Av. egg wt. per clutch in 10 clutches was 6.39 g. (5.74 g. to 7.05 g.); 25 individual eggs ranged from 5.50 g. to 7.37 g. Av. egg vol. per clutch in 8 clutches was 6.29 cc. (5.92 cc. to 6.73 cc.); 13 individual eggs ranged from 5.75 cc. to 6.92 cc. and reached 1.0 sp. gr. relatively early, 5 days before hatching. Ave. neonatal wt. per clutch in 13 clutches was 5.02 g. (4.56 g. to 5.80 g.); 29 individual neonates ranged from 4.33 g. to 6.05 g. Longest incubation period was 295 ± 1 hr.; the next longest was 289 ± 0 hr. from a fresh egg, first one laid in the clutch. Shortest interim between first and last hatching in a complete clutch of 4 eggs was 43 ± 10 hr.; others recorded were 48 ± 15 hr. for a complete clutch of 4 eggs and 49 ± 5 hr. for a complete clutch of 3 eggs. The neonate was light pink with long light salmon down, darker at tips. The mouth was yellow becoming orange medially; the rictal flanges were whitish. Surprisingly, for an "altricial" bird, the eyes opened when the bird gaped. One chick from a clutch that had accidentally been chilled for 5 hr. on the sixth day before hatching had very short down; however, another of the same clutch, that hatched several hr. later than the odd one, was normal. Red-winged Blackbird eggs substituted for incubated Robin eggs were missing the day after they were introduced.

Wood Thrush *Hylocichla mustelina*. Av. complete clutch wt. of 3 clutches with 3 eggs each was 14.90 g. (14.30 g. in 1 clutch 10 days before hatching and 15.23 g. in another 8 days before hatching). Av. egg wt. per clutch in 4 clutches was 5.26 g. (4.77 g. to 1.14 g.); 10 individual eggs ranged from 4.46 g. to 6.14 g. Av. egg vol. per clutch in 3 clutches was 5.17 cc., ranging for 5 individual eggs 4.70 cc. to 5.78 cc. The only egg determined reached 1.0 sp. gr. 9 days before hatching. Av. neonatal wt. per clutch in 4 clutches 3.46 g. ranging for 7 individual eggs 2.86 g. to 4.00 g. Longest incubation period was 335 ± 3 hr., for an egg that hatched at the small end. This egg was believed to be almost fresh though it was taken from a clutch of 3 eggs from under the hen at 4 p.m. Another egg from this clutch hatched with a relatively large unretracted yolk sac. It is noteworthy that this rare observation was recorded also in another just-hatched Wood Thrush. The shortest interim for total hatching of a clutch was 16 ± 6 hr.; another 38 ± 9 hr. and a third, from which only 2 of 3 eggs hatched, 32 ± 5 hr. The neonate had a yellow-orange mouth with pale yellow rictal flanges. The bill, anterior to the nares, was gray. One chick at incubation temperature respired 24 times per minute. Three eggs of a Catbird substituted for the 3 incubated eggs of a Wood Thrush were missing the next day. An egg of the Wood Thrush was found on the ground May 26; no nest in the vicinity could be found. This fresh egg underwent some development in the incubator then died.

Eastern Bluebird *Sialia sialis*. Clutch wt. of 1 complete clutch of 5 eggs 5 days before hatching was 14.27 g. Av. egg wt. per clutch in 3 clutches was 2.92 g. (2.79 g. to 3.12 g.); 12 individual eggs ranged from 2.56 g. to 3.21 g. Egg vol. from 1 clutch only av. 2.94 cc. (2.88 cc. to 3.05 cc.). Av. neonatal wt. per clutch in 4 clutches 2.17 g. (2.05 g. to 2.28 g.); 12 individual chicks ranged from 2.00 g. to 2.42 g. Longest incubation period was 329 ± 6 hr. with another from the same clutch of 4 eggs 323 ± 0 hr.; another single fresh egg hatched in 322 ± 6 hr. Interim between first and last hatchings was 14 ± 13 hr. for a complete clutch of 5 eggs, 4 of which hatched. In another clutch 3 of 5 eggs hatched over an interim of 11 ± 9 hr. The neonate was on the yellow side rather than the pink side of flesh-color with decidedly yellow color on the legs, toe nails and bill. The eyeballs were comparatively large presenting chunkier conformation of the head than that of non-turdids. The down was black.

Blue-gray Gnatcatcher *Polioptila caerulea*. Two complete clutches of 5 eggs respectively weighed 5.21 g. 7 days before hatching and 4.89 g. 5 days before hatching. Av. egg wt. per clutch of 6 clutches was 1.02 g. (0.95 g. to 1.14 g.); 20 individual eggs ranged from 0.91 g. to 1.18 g. Av. egg dimensions per clutch for 6 clutches were 1.47 mm. x 1.16 mm. Av. neonatal wt. per clutch in 5 clutches was 0.75 g. (0.69 g. to 0.79 g.). One chick weighed 0.63 g., another 0.87 g. Longest incubation periods were 320 ± 6 hr. and 312 ± 0 hr. While

no clutch hatched completely, data on the incomplete hatchings indicate that 8 hr. is about the normal span of opening of the whole clutch. A nest under observation was completed fully a week before the first egg was laid. After the removal of the first 2 eggs no more were laid. The neonate was unusual in two respects: there was absolutely no down and the very pale cream mouth was marked by a pair of contrasting black spots on the tongue. The skin of the head and back was dark gray as was also the tip of the otherwise flesh-color upper mandible.

Cedar Waxwing *Bombycilla cedrorum*. Four chicks from a clutch of 5 eggs hatched over a span of 57 ± 3 hr. The neonate was pink and with no down. The red mouth was bordered by thin light yellow of the horny bill, the gape was comparatively wide but without rictal flanges. The observation of Saunders (1956) that the just-hatched waxwing has violet-blue lines in the mouth should be further investigated. We observed no such lines and suspect the report may have resulted from fruits eaten by the young.

Loggerhead Shrike *Lanius ludovicianus*. A clutch of 5 fresh eggs av. 4.56 g. (4.33 g. to 4.71 g.). Av. dimensions were 24.5 mm. x 18.1 mm. A single chick hatched in 308 ± 0 hr. and weighed 3.33 g. The parent of that chick laid egg *c* the day after *a* and *b* were removed; eggs *d* and *e* respectively were also laid in the emptied nest. The neonate had light gray skin, a pair of black spots on either side of the egg tooth, and a yellow mouth with buffy yellow rictal margin. There was some short white down on the rectrices, secondary coverts and abdominal ventral region only.

Starling *Sturnus vulgaris*. Av. complete clutch wt. of 4 clutches was 37.77 g. A clutch of 4 eggs weighed 27.65 g., a clutch of 5 eggs 40.69 g. and 2 clutches of 6 eggs 48.48 g. and 34.24 g. The latter was weighed 1 day before hatching, the others 8 days. Av. egg wt. per clutch in 8 clutches was 7.10 g. (5.71 g. to 8.14 g.); 34 individual eggs ranged from 5.44 g. to 8.39 g. Av. egg vol. per clutch in 8 clutches was 6.88 cc. (5.60 cc. to 7.75 cc.); 23 individual eggs ranged from 5.44 cc. to 7.89 cc. Eggs were also widely variable, independent of size, in the number of days before hatching in reaching 1.0 sp. gr., 8 to 2 days. Av. neonatal wt. per clutch in 6 clutches was 5.27 g. (4.07 g. to 6:30 g.); 18 individual neonates ranged from 3.82 g. to 6.43 g., the differences supposedly accounted for by unassimiliated (but retracted) yolk, rather than by bodily development. Halbersleben and Mussehl (1921-22) found that chick wt. in *Gallus* was 64 percent of egg wt. regardless of differences in egg wt. (See also Heinroth, 1922: 72.) At 35 days these wt. differences had disappeared. Our data do not yield any reasonably long incubation period record. However, 2 complete clutches of 6 eggs each hatched over a span of 16 ± 5 hr. and 23 ± 9 hr. The skin of the neonate was orange-pink, the down gray in front and white posteriorly, the toenails white. The rictal flanges were enormous and bright yellow like the inside of the mouth.

White-eyed Vireo *Vireo griseus*. Two fresh eggs weighed 1.80 g. and 1.69 g. and had av. dimensions of 17.9 mm. x 13.5 mm. The neonates weighed 1.35 g. and 1.31 g. respectively. Both hatched in 350 ± 7 hr. The skin was flesh-color, the mouth and small rictal flanges light yellow, the tip of the upper mandible gray.

Red-eyed Vireo *Vireo olivaceus*. Av. egg wt. per clutch in 2 clutches was 2.36 g.; 5 individual eggs ranged from 2.21 g. to 2.43 g. Vol. of 1 egg 2.25 cc. Neonatal siblings weighed 1.60 g. and 1.91 g. Another complete clutch of 3 eggs (exclusive of a cowbird egg) took 35 ± 9 hr. to open from first to last. It is noteworthy that the most advanced embryo in a clutch candled very early in development was overtaken 9 ± 6 h. in hatching by the next-to-most advanced. It is a common belief among aviculturists that "the older the germ the longer the incubation." "One (each ?) day of storage delayed hatching 50 minutes" in chickens (D. W. MacLaury, pers. comm.). The neonate was yellow-orange including the inside of the mouth. The vireo's eyes were large, like those of the Eastern Bluebird.

Philadelphia Vireo *Vireo philadelphicus.* One that had just hatched under natural incubation had light yellow-orange body and bill with toe nails noticeably white. Inside of the mouth was yellow, the short natal down light gray.

Warbling Vireo *Vireo gilvus.* Three eggs from a complete clutch of 4 eggs av. 1.65 g. (1.53 g. to 1.77 g.). One of these eggs had vol. 1.75 cc. and reached 1.0 sp. gr. 8 days before hatching. Av. neonatal wt. of 3 chicks was 1.23 g. (1.13 g. to 1.32 g.). These hatched 1 each day, totaling 43 ± 18 hr. interim. Their skins were yellow-orange.

Yellow Warbler *Dendroica petechia.* A complete clutch of 5 eggs weighed 7.85 g. 9 days before hatching. Av. egg wt. of these eggs was 1.57 g. (1.52 g. to 1.63 g.). Av. vol. was 1.54 cc. (1.50 cc. to 1.57 cc.) and reached 1.0 sp. gr. 5 days before hatching. Neonatal wt. of 3 chicks from 2 clutches av. 1.14 g. (1.05 g. to 1.20 g.). Two eggs that hatched successfully from a clutch of 5 opened 21 ± 5 hr. apart. The skin was yellow-orange and the down white. Longest incubation period of 267 ± 2 hr. seemed too short to be representative when compared to non-parulids, but there was every reason to believe that the egg was fresh when collected. That fact is emphasized because the skeletons of these warblers are remarkably advanced for 270-hr.-old avian embryos.

Chestnut-sided Warbler *Dendroica pennsylvanica.* Four eggs from a clutch of 4 (exclusive of a cowbird egg) av. 1.41 g. (1.32 g. to 1.57 g.). Av. vol. of 3 eggs 1.41 cc. (1.29 cc. to 1.54 cc.). The single neonate that hatched successfully weighed 0.97 g. Longest incubation period was 268 ± 4 hr.

Prairie Warbler *Dendroica discolor.* A complete clutch of 4 eggs weighed 5.51 g. 9 days before hatching (1.35 g. to 1.41 g.). Two neonates weighed 1.00 g., another 0.94 g. The skin was yellow-orange with a blood vessel on the right side of the neck showing conspicuously red, the mouth was light yellow with paler rictal flanges, down dark gray.

Ovenbird *Seiurus aurocapillus.* Clutch wt. respectively 11.24 g. for a complete clutch of 5 eggs 4 days before hatching and 11.01 g. for a clutch of 4 eggs 8 days before hatching. Av. egg wt. per clutch for 2 clutches was 2.50 g. (2.25 g. to 2.75 g.); 9 individual eggs ranged from 2.12 g. to 2.89 g. Vol. of 1 egg 2.65 cc. Av. neonatal wt. per clutch for 3 clutches was 1.88 g. (1.70 g. to 2.09 g.); 12 individual chicks ranged from 1.45 g. to 2.19 g. A complete clutch of 5 eggs hatched within 16 ± 0 hr. from first to last egg; a complete clutch of 4 eggs hatched within 24 ± 8 hr. The neonate had a yellow bill and rictal flanges, the mouth red, down medium gray but darker on the head.

Yellowthroat *Geothlypis trichas.* Av. egg wt. of 4 individual eggs from 2 clutches was 1.86 g. (1.78 g. to 1.93 g.). Av. vol. of 4 eggs was 1.82 cc. (1.75 cc. to 1.89 cc.); they reached 1.0 sp. gr. 8 days before hatching. The eggs of this species seemed disproportionately large for the size of the adult; av. egg dimensions 1.45 mm. x 1.93 mm. Av. neonatal wt. of 6 chicks from 4 clutches 1.24 g. (0.90 g. to 1.14 g.). Longest incubation period was 256 ± 12 hr. A set of 3 (exclusive of a cowbird egg) had a total hatching span of 16 ± 5 hr.; another complete clutch of 4 eggs 22 ± 19 hr. The neonate was light orange with dark gray down. The teleoptile remiges (or the greater coverts ?) already showed through the skin as pigment spot. The mouth was light reddish orange, bordered by the yellow edge of the bill; the rictal flanges which were noted to be very rounded were yellow, as were also the toe nails.

House Sparrow *Passer domesticus.* Av. complete clutch wt. for 5 clutches was 14.33 g. (12.55 g. for a clutch of 4 eggs 4 days before hatching and 17.73 g. for a clutch of 6 eggs 11 days before hatching). Av. egg wt. per clutch for 30 clutches was 2.78 g. (2.27 g. to 3.34 g.); 85 individual eggs ranged from 1.87 g. to 3.36 g. Av. egg vol. per clutch for 27 clutches was 2.63 cc. (2.15 cc. to 3.15 cc.); 76 individual eggs ranged from 1.75 cc. to 3.16 cc. Sp. gr. of 1.0 was reached on the av. 5 days before hatching but varied from 1 day to 9 days before hatching. Av. neonatal wt. per clutch for 30 clutches was 2.02 g. (1.73 g. to 2.74 g.); 58 individual chicks ranged from 1.58 g. to 2.83 g. Longest incubation period was

282 ± 3 hr. with many other records closely crowding this one. The interim between first and last egg hatching was variable. Where all eggs of the clutch hatched successfully the interval in one clutch with 4 eggs was 10 ± 3 hr.; in another 36 ± 6 hr. For complete clutches of 5 eggs 1 clutch in which 4 hatched successfully all chicks emerged in 0 ± 7 hr.; in another of the same success, 10 ± 5 hr. In a complete clutch of 6 eggs 5 hatched in 58 ± 8 hr. One clutch that was deposited after the "rookery" had been twice thoroughly robbed had 2 light colored eggs and 3 that were completely white. We think that the rapidly repeated layings exhausted available pigment. These pale eggs showed normal hatchability. Another clutch with exceedingly narrow, elongated eggs hatched without singularity. A chick that was noted to be unusually small (1.66 g.) and with blanched skin was hatched in proper time from an egg not noticeably abnormal in any respect. The neonates were naked and the skin was light gray especially on head and dorsum. The mouth was red and contrasted with the bright yellow rictal flanges which were broad and thick in this species.

Red-winged Blackbird *Agelaius phoeniceus*. Av. clutch wt. of 4 clutches of 4 eggs each was 14.76 g. (12.14 g. 8 days before hatching and 16.53 g. 10 days before hatching). Av. egg wt. per clutch for 14 clutches 3.98 g. (3.04 g. to 4.66 g.); 37 individual eggs ranged from 2.80 g. to 5.39 g. Av. egg vol. per clutch for 10 clutches 3.85 cc. (3.02 cc. to 4.24 cc.); 28 individual eggs ranged from 2.80 cc. to 4.32 cc. They reached 1.0 sp. gr. on the av. 6 days before hatching but ranged from 4 to 9 days. Av. neonatal wt. per clutch for 12 clutches was 2.75 g. (2.14 g. to 3.21 g.); 29 individual neonates ranged from 1.83 g. to 3.32 g. Longest incubation recorded 263 ± 1 hr.; this seemed too short to be representative. Two complete clutches of 4 eggs each in which all eggs hatched successfully hatched over a span of 23 ± 9 hr. All other complete clutches, in which hatching was less successful, hatched in less time than the above except 2 clutches, 40 ± 6 hr. and 33 ± 9 hr. The neonate was bright orange-red. It is noteworthy that the yolk of the Red-winged Blackbird egg is of this same color, probably xanthophyl determined and derived from phytophagus insect larvae.

Baltimore Oriole *Icterus galbula*. The youngest of 5 nestlings thought to be just-hatched weighed 2.63 g.; the others showed the probable progression in staggered hatching, 4.26 g., 6.91 g., 7.86 g. and 7.85 g. The skin and mouth were orange-pink, toe nails yellow, down light buffy yellow. The underside of the flat, unswollen rictal flanges was bright red. We were unable to determine whether this coloring, noted in several other species, was from underlying blood vessels or was a pigment deposition; probably the former. (See discussion under Field Sparrow.) This chick uttered no sound.

Common Grackle *Quiscalus quiscula*. Av. egg wt. per clutch of 4 clutches was 6.76 g. (5.57 g. to 9.20 g.); 14 individual eggs ranged from 5.26 g. to 9.93 g. Av. egg vol. per clutch of 4 clutches 6.57 cc. (5.32 cc. to 8.96 cc.); 12 individual eggs ranged from 5.16 cc. to 9.40 cc. They reached 1.0 sp. gr. on the av. 8 days before hatching with a range from 5 to 10 days before hatching. Av. neonatal wt. per clutch from 5 clutches 4.96 g. (3.50 g. to 6.58 g.); 14 individual chicks ranged from 3.50 g. to 7.03 g. Longest incubation period recorded was 310 ± 0 hr.; the clutch was possibly complete. The last chick hatched 21 ± 0 hr. after the first. In 1 clutch of 5 eggs of which 4 hatched successfully all chicks emerged within 6 hr. of one another. A clutch of 5 eggs had 3 hatch over a 30 ± 4 hr. span. The neonate had a red mouth with white, moderately flared rictal flanges. The down was black, toe nails white, tip of upper mandible medium gray.

Brown-headed Cowbird *Molothrus ater*. Av. egg wt. for 10 eggs was 3.03 g. (2.63 g. to 3.36 g.). Av. vol. of 7 eggs 2.75 cc. (2.22 cc. to 3.15 cc.); these reached 1.0 sp. gr. 5 to 8 days before hatching. Av. neonatal wt. of 9 chicks 2.22 g. (1.85 g. to 2.68 g.). Longest incubation period recorded was 297 ± 6 hr. The neonate had a red mouth with moderately flared, pale rictal flanges; the bill was slightly prognathous. The down was light buffy yellow becoming white posteriorly. It may be coincidental but only 1 of 10 cowbird eggs incubated artificially was found newly hatched at a time other than early morning; the

hatching of the hosts' eggs of the same clutches was evenly distributed over the night and day.

The immediate biological effects of the introduction of the cowbird egg are great and probably underestimated by most observers. Much of the damage is done long before the egg is hatched. When our data were segregated as to cowbirds that hatched in our incubator successfully on the one hand and unsuccessfully on the other, the 6 unsuccessful eggs were in hosts' clutches that were also almost totally unsuccessful in hatching; while the successful cowbird eggs were in successful hosts' clutches. Our interpretation is that these unsuccessful clutches were deserted. Inconspicuous physical damage to at least some of the hosts' eggs was detected in most instances by the candler. In addition it was often suspected that some hosts' eggs were removed and never found by us. It is the instinctive habit of chickens to eat an egg that is cracked or dented and the same habit may be applicable to cowbird hosts.

Following are some detailed case histories: *A.* Eastern Phoebe; 2 of 4 of the host's eggs failed to hatch. The cowbird egg hatched 64 ± 4 hr. before the first phoebe egg and 192 ± 99 hr. before the last. The relatively long incubation period of the phoebe may deter successful cowbird parasitism. *B.* Eastern Phoebe; 2 of the host's eggs were pierced, the third never developed; the cowbird egg also did not develop. *C.* Eastern Phoebe; no eggs save the cowbird egg were found. It did not develop. *D.* Red-eyed Vireo; 2 of the host's eggs were cracked and the third embryo eventually died. The cowbird egg hatched. *E.* Red-eyed Vireo; 1 egg was laid by a cowbird but destroyed by human agency before the vireo commenced to lay. The second cowbird egg hatched 17 ± 15 hr. before the first vireo's egg and 52 ± 16 hr. before the last (third) vireo's egg. *F.* Red-eyed Vireo; 1 of the host's eggs hatched; the other 3 died in the shell. The cowbird egg did not hatch. *G.* Black-and-white Warbler; 3 of the host's eggs hatched under natural incubation before we found the nest. This was 6 full days before the cowbird egg hatched in our incubator. One of the host's eggs was found pierced and a foot away from the nest. *H.* Yellow Warbler; the first egg of the host was punctured; the second was missing and a cowbird egg was in its place; the next day the host laid another egg, then the clutch was collected. The cowbird egg hatched 11 ± 8 hr. before the host's third egg. *I.* Chestnut-sided Warbler; 1 of the 4 host's eggs hatched; the cowbird egg did not. *J.* Ovenbird; the cowbird egg hatched 8 ± 7 hr. before the first Ovenbird's egg and 34 ± 8 hr. before the third (last) Ovenbird's egg. *K.* Yellowthroat; of the 2 host's eggs I had 2 tiny holes and failed to hatch; the other hatched 22 ± 20 hr. after the cowbird egg. *L.* Yellowthroat; the cowbird egg hatched within 0 ± 5 hr. of 2 of the host's eggs and 16 ± 5 hr. before the third (last) egg. *M.* Red-winged Blackbird; neither the 1 blackbird's egg nor the cowbird egg hatched. *N.* Rufous-sided Towhee; 1 of the 2 towhee embryos died in the shell. The cowbird egg hatched 16 ± 7 hr. before the successful towhee's egg. *O.* Rufous-sided Towhee; 1 towhee egg was broken; the other did not hatch. The cowbird egg hatched. *P.* Song Sparrow; neither the host's 4 eggs nor the cowbird egg hatched. *Q.* Two eggs believed to be of the cowbird were found together on a wood path May 30; no nest could be found in the vicinity. The eggs failed to develop.

Scarlet Tanager *Piranga olivacea.* Av. egg wt. per clutch for 2 clutches was 3.38 g. with 5 individual eggs ranging from 3.10 g. to 3.65 g. Av. egg vol. for 3 eggs of 1 clutch 3.40 cc. (3.34 cc. to 3.47 cc.). These reached 1.0 sp. gr. 4 days before hatching. Neonatal wt. of 2 siblings was 2.70 g. They hatched 2 hr. apart; the third egg of the clutch did not hatch. Artificial incubation for this clutch was 264 ± 0 hr., but the eggs were probably not fresh. The neonate had a pink mouth and silvery gray down.

Cardinal *Richmondena cardinalis.* Av. complete clutch wt. in 5 clutches of 3 eggs each was 12.62 g. (11.82 g. to 13.76 g.). Av. egg wt. per clutch in 6 clutches 4.27 g. (3.94 g. to 4.59 g.); 12 individual eggs ranged from 3.65 g. to 4.87 g. Av. dimensions per clutch 24.7 mm. x 17.9 mm. The skin of the neonate was orange, the mouth red with cream rictal flanges, the bill already cardueline in shape. The down was black, contrary to my previous belief (Wetherbee, 1957) that cardueline finches have white natal down. Inexplicably, of 17 eggs of this species incubated artificially under standard conditions, only 1 hatched. The incubation period was 298 ± 9 hr.

Rose-breasted Grosbeak *Pheucticus ludovicianus.* Clutch wt. on a complete clutch of 4 eggs was 16.92 g. 10 days before hatching. Av. egg wt. per clutch for 3 clutches was 3.94 g. (3.38 g. to 4.23 g.); 9 individual eggs ranged from 3.14 g. to 4.39 g. Av. egg vol. in 1 clutch of 4 eggs was 4.07 cc. (3.96 cc. to 4.24 cc.). They reached 1.0 sp. gr. 5 days before hatching. Neonatal wt. of 3 individuals ranged from 2.82 g. to 3.29 g. (av. 3.10 g.). Longest incubation period recorded was 294 ± 5 hr. In one complete clutch of 4 eggs in which only 3 hatched the span between first and last hatching was in excess of 58 hr. An incomplete clutch of 3 eggs hatched 25 ± 11 hr. from first to last. As 2 of these hatched simultaneously, incubation probably commenced with the second egg. If it can be assumed that at least 4 eggs composed the potential clutch and that 1 egg is laid each day in the morning, then the longest incubation period given above plus about 12 hr. represents the true period for this species. In chickens, however, afternoon laying becomes more frequent as the hen's age increases; therefore morning laying is not always a safe assumption. The skin of the neonate was orange like that of the Red-winged Blackbird; the down was white except on the head where it was gray. The mouth, especially the tongue, was reddish orange and was bordered by the yellow of the edge of the mandibles; the pale yellow rictal flanges were only slightly flared; the toe nails were white.

Indigo Bunting *Passerina cyanea.* One egg, which had been laid shortly after the first 2 had been removed by a predator, weighed 2.01 g.

Purple Finch *Carpodacus purpureus.* Three eggs from 2 clutches weighed 1.86 g. to 2.09 g. (av. 2.00 g.); vol. ranged from 1.76 cc. to 2.04 cc. (av. 1.92 cc.). None of these eggs hatched successfully; longest embryonic life was 274 ± 0 hr.

Rufous-sided Towhee *Pipilo erythrophthalmus.* Weights of 3 eggs from 2 clutches ranged from 3.60 g. (just before hatching) to 3.98 g. (av. 3.28 g.). Neonatal wt. of 2 chicks from different clutches were 3.05 g. and 3.08 g. The mouth of the neonate was red in sharp contrast to the bordering yellow bill.

Chipping Sparrow *Spizella passerina.* Av. egg wt. per clutch in 4 clutches was 1.54 g. with 10 individual eggs ranging from 1.35 g. to 1.66 g. Av. vol. of 4 eggs from 3 clutches was 1.50 cc. (1.39 cc. to 1.58 cc.). These reached 1.0 sp. gr. 6 days before hatching. Av. neonatal wt. per clutch in 3 clutches was 1.09 g. with 8 individual chicks ranging from 0.98 g. to 1.27 g. Longest incubation period recorded was 274 ± 10 hr. The interim between first and last hatching in a complete clutch of 4 was 22 ± 16 hr., probably nearer 22 ± 6 hr., one chick having died before the incubator was tended. A third egg in one instance was laid after the first 2 eggs had been robbed. The neonate was dull orange with dark gray down. The tip of the bill was gray, the toe nails white. The mouth was reddish bordered by the yellow of the edge of the bill; the rictal flanges were light yellow.

Field Sparrow *Spizella pusilla.* Av. complete clutch wt. of 4 clutches of 4 eggs each was 6.51 g. with extremes respectively of 6.01 g. 8 days before hatching and 7.14 g. 7 days before hatching. Av. egg weight per clutch in 7 clutches was 1.67 g. (1.55 g. to 1.86 g.); 24 individual eggs ranged from 1.42 g. to 1.92 g. Av. vol. for 5 eggs from 2 clutches was 1.66 cc. (1.43 cc. to 1.86 cc.). Sp. gr. of 1.0 was reached 7 days before hatching. Av. egg dimensions per clutch were 17.8 mm. x 13.2 mm. Av. neonatal wt. per clutch for 5 clutches was 1.23 g. (1.09 g. to 1.41 g.); 11 individual chicks ranged from 1.05 g. to 1.41 g. As 231 ± 0 hr. was the longest incubation period recorded, we believe that further work is indicated. The interim between hatching of the first and last chick in a complete clutch of 4 eggs was 24 ± 8 hr. Eggs were laid daily. The neonate was light orange with down that varied from light to dark gray. The upper mandible was gray on the anterior half; the mouth was bright red and the rictal flanges light yellow.

In the Field Sparrow as in some other species, the color of the mouth is dark in the preserved specimen, while in other species the mouth coloration disappears upon preservation of the specimen. This dark color is presumably caused by vascularity and therefore suggests that some oxygen exchange may take place in the nestling's mouth. This interpretation of mouth color is especially favored by Daniel's (1957) contention that the early respiratory activity of "altricial" birds

is relatively inefficient because of incomplete fusion of the para-bronchi of the lungs.

Swamp Sparrow *Melispiza georgiana.* Clutch wt. of a complete clutch of 4 eggs 10 days before hatching was 8.25 g.; av. egg wt. 2.06 g. (1.85 g. to 2.15 g.). Av. neonatal wt. of 3 of these chicks was 1.46 g. (1.37 g. to 1.55 g.). Av. dimensions of 5 eggs in 2 clutches were 19.8 mm. x 15.0 mm. Three of a clutch of 4 hatched over an interim of 12 ± 8 hr. The neonates were described in detail elsewhere (Wetherbee, *in* Bent, ms.). Their skin was pink and the down dark gray; mouth pink with pale yellow border.

Song Sparrow *Melospiza melodia.* Four eggs from a partly incubated clutch av. 2.35 g. Three young that hatched successfully from a clutch of 4 eggs emerged over a span of 39 ± 10 hr. The mouth of the neonate was salmon color.

Summary. The artificial incubation of eggs of 83 species of wild birds is described. Determinations of magnitudes are reported for egg weights, clutch weights, egg volumes, incubation periods, interims between hatchings within clutches, and number of days before hatching during which eggs float. Colors of natal down and soft parts, especially of mouth linings are given. Extent of development judged by behavior is noted. This paper attempts to establish procedural standards under standardized conditions that may allow for more accurate and more significant interspecific comparisons of incubation and neonatal condition independent of parental attentiveness in incubation and of other environmental variables.

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A TEST FOR RANDOMNESS IN TRAPPING[1]

BY HOWARD YOUNG

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When certain information, such as sex-ratio, comparative abundance, age distribution, etc., is sought from a trapping program, the investigator desires what is commonly referred to as a random sample. In general this is taken to mean that there are no artificial distortions of the data—that the trapped sample is an accurate representation of the population being studied.

Where only single captures are required, such as in some bird-banding programs, or in small mammal snap-trapping studies, the problem is simpler than in programs where individuals are marked and released for recapture attempts. In the latter case one has to have information about the randomness of recaptures as well as original captures (Young, Neess, Emlen, 1952; Young, 1958).

This paper concerns itself with the randomness of original captures, and makes use of a technique first described by Mood (1940), which may be described as the "theory of runs." For a particularly lucid discussion, see Freund (1952). In brief, this relates to the internal structure of the sample, i.e., the sequence in which the data occur.

The use of this technique can be described by taking some material from the author's bird-trapping records. From January 29, 1958 to April 21, 1958, a ten trap banding station was in operation in a local cemetery. All the traps were single-cell Potter-type traps, permanently located, and uniformly baited with scratch feed. The Slate-colored Junco, *Junco hyemalis*, was one of the species captured. The data were first organized by designating as A any day on which at least one junco was caught, and as B any day on which no juncos were captured. These were then arranged in their natural chronological sequence, giving the pattern shown below:

BB A B AA B AA B AAA B A BBB A BB A B A BBBBBB AAAA BBB A BB A BBBB A BBBBB A

Field biologists are frequently plagued by small samples, such as this one, and in these cases it is particularly desirable to have information about the randomness of the sample. The technique here described is applicable as long as A and B each equal at least ten. The question to be answered is whether or not this is a random arrangement of A's and B's. Simple counting shows that there are twenty A's and thirty-two B's, and that there are twenty-six runs of either A or B. A run is a sequence of one letter followed and preceded by the other letter, or by none at all. We may designate the runs by the symbol u.

This test helps us decide whether the runs are too numerous or too few to constitute a random sample. To do this we make use of the following formulae:

1) $\mathrm{mu} = \dfrac{2AB}{A} + B + 1$

and

2) $\sigma u = \sqrt{2AB(2AB - A - B)/(A + B)^2\ (A + B - 1)}$

If the total number of runs is less than mu — 1.96σu, or greater than mu + 1.96σu, the sample probably is non-random. If it falls between these two limits the sample does not show any significant (5% level) deviation from randomness.

In the particular case here considered, mu = 25.62, σu = 11.33. Therefore mu + 1.96σu is 47.83 and mu — 1.96σu is 3.41. Since u = 26 falls within these limits, there seems to be no apparent deviation from randomness. This gives the investigator a certain amount of confidence in completing more detailed analyses, such as sex-ratios, recapture ratios, etc.

From January 29, 1958 to March 26, 1958, Chickadees, *Parus atricapillus*, were also captured at the same station. The original data can be examined in the same way as that for the junco. For the chickadee the results are A = 30, B = 19, and u = 23. Using the preceding formulae we obtain mu + 1.96σu = 25.56, mu — 1.96σu = 20.28, and u again falls within the indicated range of randomness.

During 1958-1959, traps were operated for 103 days during the period from Nov. 3, 1958 to April 3, 1959. English Sparrows, *Passeres domesticus*, were abundant in the area, and often seen in the immediate vicinity of traps. Examination of the trapping data on these birds gives the following: A = 21, B = 82, u = 21. It can be seen that sparrows were caught on about 1 day out of 5. Analysis shows that mu + 1.96σu is 40.83, mu — 1.96σu is 28.05. As u fails to fall within these limits, it appears that capture was not random.

Where definite suggestions of a non-random behavior are present, the application of more advanced statistical procedure must be carried out with distinct reservations, if at all.

Another situation might arise in which captures were made every day the traps were set, or almost every day. Where trapping success has been this good it is still possible to apply the "runs" test by computing the average number caught per day, and then designating as A those days on which more than the average were caught, and as B those days when fewer than the average were caught.

The author is not this efficient a trapper. However, data approaching this condition are available from the trapping of juncos during the winter of 1958-1959. From Dec. 18, 1958 to April 3, 1959, juncos were caught on 49 (79%) of the 62 days on which traps were set. Initial analysis showed that the capture-non-capture days produced a non-random pattern. During this period there was a total of 105 captures of juncos, an average of 1.7 per day. Days on which 2 or more juncos were caught were designated as A, those on which 1 or zero juncos were caught were designated as B. On this basis, A = 30, B = 32, u = 29. Computations show that mu + 1.96σu = 60.76, mu — 1.96σu = 1.18, and u falls well within the limits of randomness. This indicates a lack of significant "bunching" of captures.

Establishment that the original captures followed a random pattern of course does not release the investigator from further statistical responsibility. For example, suppose one were investigating the length of the residence period of a migratory species. It should be clear that this would not necessarily coincide with the period during which the birds were captured. There might well be a time-lag after arrival in

the area before the first individual was caught, and again, some might remain in the area for some time after the last capture. Evidence that they were captured in random fashion during the period in which they entered the traps would not give information on this point.

The test thus applies specifically to those individuals which are vulnerable to trapping, and provides no information about those which refuse to enter the traps for any one of various reasons.

For another example we may consider trapping reports on the Cardinal, *Richmondena cardinalis*, for a period extending from Jan. 4, 1953 to May 24, 1953. During this time the average number of cardinals caught per day was 1.6. Analysis by this "runs" method showed a random pattern of captures. However, further analysis (Young, 1958), which considered recaptures, showed that the individual birds did not repeat in random fashion.

The techniques here described would seem to be of value in preliminary consideration of small sample data. Where indications are that the sampling technique *per se* was selective, i.e., non-random (and this is often the case), the use of data drawn from the sample must be made with due caution.

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REPORT ON THE CAUSE OF MORTALITY AND THE MORPHOMETRY OF SEVENTY RUBY-CROWNED KINGLETS KILLED AT THE WENH-TV TOWER IN DEERFIELD, NEW HAMPSHIRE

BY PHILIP J. SAWYER

The University of New Hampshire began use of the educational TV channel 11 in 1959 in conjunction with other educational institutions in New Hampshire. Part of the installations constructed to activate the station consist of a supported tower 360 feet high topped by a 12 bay antenna, one foot in diameter and 76 feet high. This structure was erected at a point about 1100 feet in elevation on Saddleback Mountain in Deerfield, N. H. The tower is guyed at three points equi-

distant from each other. There are four cables running from the ground up to the tower from each of these three areas. They are attached at the 100, 200, 300 and 400 foot levels of the tower. This makes the total unit consist of the 436 foot structure plus its 12 supporting guy wires. Several papers have appeared in past years concerned with bird mortality at various types of structures associated with radio, television and air bases. (Howell, Laskey and Tanner, 1954, Johnston and Haines, 1957, Kemper, 1958.) With this information in mind, advantage was taken of the opportunity to study any possible mortality that might be associated with this new obstruction near the Atlantic Coast. This investigation began in April, 1959, during the first spring the tower was present on the mountain. This paper is concerned with part of the mortality that occurred on the night of October 13-14, 1959. Seventy-four Ruby-crowned Kinglets were found among the 130 birds killed that night. Seventy of these specimens were in good enough condition to be used for the purposes of this investigation.

The dimensions of the Ruby-crowned Kinglet are known, of course, but a search of the literature failed to uncover measurements of a group of kinglets similar to the one discussed here. The sample included mature and immature males and females, all collected at once, and taken at random from a fall-migrating flock.

METHODS

The measurements recorded consisted of weight, total length, bill length, wing length, tarsus length, extent and tail length. These dimensions were taken as described in Pettingill, 1956. The age of the birds was determined by search for the Bursa of Fabricius in the cloaca. If it was found to be present, the bird was called immature, if absent, the individual was considered adult (Pettingill, 1956). It was impossible to distinguish adults from immatures by their plumage, except in a few cases. Some juvenile males had only two or three red feathers in their crown and were properly called immature before their large bursae of Fabricii were dissected out. The maturity of the females could not be judged externally. The postjuvenal molt is accomplished before the bird migrates. It involves the contour plumage and the wing coverts, but not the rest of the wings and tails. This produces a first winter plumage which is practically indistinguishable from that of the adult in each sex (Bent, 1949).

WEATHER ASSOCIATED WITH THE MORTALITY PERIOD

Weather conditions are very often responsible for migratory accidents and Devlin and Wykoff (1957) have shown diagramatically how mortality may be associated with weather fronts. A certain amount of information concerning the weather conditions during the night of October 13-14, 1959 is available even though no meteorological equipment was installed on Saddleback Mountain. The engineer in charge of transmission at the tower recorded a temperature of 48°F on the mountain top early in the evening of October 13, 1959 and one of 32°F early in the morning of October 14, 1959. This data is not precise, but it does show a drop of air temperature of 16°F which might well accompany a change of air mass. More authoritative in-

formation was obtained from Mr. Robert E. Lautzenheiser, State Climatologist, Weather Bureau, U. S. Department of Commerce, Boston, Massachusetts (personal communication). He was able to describe, from records available to him, an area of light rain that occurred around 2:00 A.M. and a little later on October 14, 1959, just south of Saddleback Mountain. I quote from his letter: "Though Saddleback appears to be in the area of no rain that night, the extra elevation of the mountain may possibly have caused locally some small amount of rain. Height of the clouds also may have been lower at the Mountain. Ceiling or cloud height at 2 A.M. Daylight time was reported as 2700 feet at Boston and 3500 feet at Concord. Horizontal visibility was good at both places, 8 and 20 miles, respectively, at that time."

When he considered temperature his comments were as follows: "The maxima on the 14th were only slightly lower, by 4 to 8° or so, than the maxima of the previous day. This would not indicate an important cold front in the area, but rather a gradual influx of cooler air from the high pressure area to the west as the rain area moved out."

Mr. Lautzenheiser requested comments from Mr. Richard Fay, Research Forecaster, Weather Bureau Airport Station, East Boston on the weather of that night. Mr. Fay described the storm that brought rain to the area south of Saddleback Mountain corroborating Mr. Lautzenheiser's statements. Some of his other remarks regarding weather about the area in question were interesting. "Low level winds (not over 2000 feet) were NW about 15 knots at 7 P.M., N 5 to 10 at 1 A.M. and NE 10 at 7 A.M. Mt. Washington temperatures ranged from 18 to 12°, where the station was in the clouds until 1 A.M. but where it cleared by morning. A guess on the lapse rate indicates that the freezing level might have been as low as 900 feet in southern N. H."

The facts quoted above seem to be meteorological bases for a speculation that conditions aloft might have been sufficiently inclement to have caused these birds to have flown at a lower than normal elevation. The 1536 foot total height of the mountain plus the tower could have extended upward into their migratory path. Therefore, the combination of weather and the occurrence of a TV antenna seem to be responsible once again for bird mortality.

MORPHOMETRY OF THE KINGLETS AND ITS STATISTICAL INTERPRETATION

Table 1 summarizes the weight and body measurements made on each bird. Examination of these data shows that adult and immature males were similar in size. The dimensions recorded for the adult and immature females show likewise the similarity between those two age groups. More obvious differences may be noted when the dimensions of the males and females are compared. The weight and measurement data were subjected to the analysis of variance. A randomized block design was used. Results of these analysis appear in Table 2.

Table 2 shows that the differences between males and females are statistically significant for body weight, total and wing length, extent, tarsus and tail measurements. The males were larger for each characteristic. Neither the sex difference in bill length nor the age difference in any of the six other traits were significant. The measurement differences between the two age groups were in no instance significant.

Table 1. Weight and linear body measurements of 70 Ruby-crowned Kinglets by age and sex.

Trait measured and measurement unit	Adult				Immature			
	Males (26)[a]		Females (20)		Males (13)		Females (11)	
	Av.	Range	Av.	Range	Av.	Range	Av.	Range
Weight (gms)	7.16	6.3-7.9	6.74	5.9-7.3	7.16	6.2-7.7	6.39	5.6-7.1
Total Length (mm)	105.6	102-111	103.2	98-108	105.0	101-108	104.3	100-108
Bill (mm)	8.8	8-10	9.0	8-10	9.0	8-10	9.1	8-10
Wing (mm)	57.1	54-60	54.1	52-58	56.8	52-59	54.6	53-55
Extent (mm)	174.0	169-180	166.7	158-174	170.9	160-182	166.5	162-170
Tarsus (mm)	18.5	18-19	17.9	17-19	18.5	18-20	17.8	17-18
Tail (mm)	44.6	42-47	41.7	39-46	44.3	41-47	41.7	40-43

[a] Number of specimens

Table 2. Analysis of variance of different measurements made on the Kinglets

Source of Variation	d.f.	Weight M.S.	Total Length M.S.	Bill Length M.S.	Wing Length M.S.	Extent M.S.	Tarsus Length M.S.	Tail Length M.S.
Sex	1	704.59**	56.0*	0.18	168.41**	5.19**	7.08**	138.85**
Age/Sex	2	42.27	6.0	0.18	1.32	0.23	0.20	0.44
Individuals	66	21.53	8.6	0.23	2.38	0.16	0.39	1.87

* = significant at the .05 confidence level
** = significant at the .01 confidence level
M.S. = mean square or variance — a measure of variation

This table summarizes the results of a statistical analysis of the comparative measurements made on the Kinglets. The object of the analysis was to test the likelihood that differences between sexes and between ages within a sex were greater than one would expect from chance alone. In conjunction with Table 1, Table 2 shows for weight, wing length, extent, tarsus, and tail length (traits with a double asterisk) that the odds are 99 to 1 that the sex differences were real. Similarly it indicates for total length (single asterisk) odds of 20 to 1 that the sex differences are real. Since an asterisk does not appear after the bill length mean square for sex, nor after any of the mean squares for age within sex, this indicates that differences found in these measurements were in all probability due to chance. Individuals mean square was used for testing sex and age within sex sources of variation for statistical significance.

SUMMARY

A partial analysis of the meteorological conditions present on the night of October 13-14, 1959, at the WENH-TV tower in Deerfield, N. H., seems to indicate that inclement weather was responsible for causing 130 birds to collide with the tower and its guy wires. Seventy Ruby-crowned Kinglets found among the casualties were grouped by sex and age. Body weight, total length, extent, wing, tail and tarsus length were greater in males than in females by a difference which was statistically significant. The sex difference in bill length was not significant. No significant difference was shown between immature and adult specimens.

ACKNOWLEDGMENTS

The Central University Research Fund of the University of New Hampshire provided the necessary funds to support this project. It is with pleasure that I acknowledge its support. Mr. Walter J. Swenson, transmitter engineering supervisor at the WENH-TV transmitter, and Mrs. Swenson collected faithfully all the birds killed at the tower. They recorded the locality at which they found the specimens, and deposited them in a deep freeze. Without their help this paper could not have been written. University of New Hampshire faculty members, Professor Owen B. Durgin, Sociology Department, and Dr. Walter M. Collins, Poultry Department, provided statistical help for which I am very grateful. Dr. Collins also made many helpful suggestions concerning the presentation of the statistical interpretation. Dr. Wilbur L. Bullock, Parasitologist, Zoology Department, University of New Hampshire, determined the presence or absence of the Bursae of Fabricii during his search for parasites in the digestive tract of the kinglets. I am pleased to acknowledge his help. Dr. John F. Reed, Dean of the College of Liberal Arts and Dean of the Graduate School of the University of New Hampshire, suggested originally that bird mortality be investigated at the TV tower.

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Appendix A — Measurements of 70 Ruby-crowned Kinglets
Adult Males in grams and millimeters

Weight	Total Length	Bill	Wing	Wing Span	Tarsus	Tail
7.8	105	8	60	173	19	46
7.9	105	9	58	171	19	45
6.9	103	8	59	174	18	47
7.5	104	9	59	175	19	45
7.3	103	8	55	167	18	44
7.1	108	9	56	167	18	45
7.2	102	9	58	170	19	44
6.9	105	8	57	171	19	44
6.5	107	9	55	175	19	45
7.7	111	8	58	174	19	45
7.1	103	9	56	171	19	43
7.1	105	9	59	180	18	47
7.5	109	9	58	177	18	47
6.7	105	8	56	174	18	45
7.8	101	9	55	174	19	44
7.1	101	9	54	168	18	45
6.6	103	9	55	175	19	42
6.3	108	9	56	178	18	44
7.2	109	9	59	180	18	44
7.4	104	9	56	177	19	44
7.3	105	10	58	172	18	45
7.2	105	9	59	180	19	45
7.1	108	9	57	172	18	44
7.4	110	10	58	179	18	44
7.1	110	9	58	178	18	44

Immature Males

Weight	Total Length	Bill	Wing	Wing Span	Tarsus	Tail
6.9	105	8	59	160	19	43
7.3	105	9	54	165	19	43
7.7	104	9	58	173	18	44
7.5	106	9	57	174	18	45
7.4	108	9	57	175	18	43
7.1	101	9	58	170	19	45
6.7	107	9	58	171	19	45
7.1	104	9	58	171	18	44
6.9	101	9	52	160	18	41
7.3	107	10	57	175	18	46
6.2	107	9	58	182	20	46
7.7	103	9	55	170	18	44
7.4	107	9	58	176	18	47

Adult Females

7.3	107	8	58	172	17	46
7.1	107	10	54	175	17	41
7.0	101	9	54	162	18	42
6.9	108	8	53	167	19	40
7.3	108	9	55	171	19	43
6.4	100	9	52	159	19	39
6.6	102	9	54	161	18	42
6.4	105	9	53	162	18	39
6.8	104	9	54	168	17	41
6.8	98	9	52	165	17	42
6.6	103	9	52	158	18	42

Adult Females (cont.)

Weight	Total Length	Bill	Wing	Wing Span	Tarsus	Tail
6.9	100	9	53	159	17	40
6.9	100	9	54	167	19	42
6.9	105	9	55	174	19	43
6.4	104	9	54	170	17	42
6.8	99	9	54	166	18	41
6.8	99	9	55	172	18	42
6.6	107	9	55	170	18	42
6.4	100	9	55	170	17	41
5.9	107	9	55	166	17	43

Immature Females

6.2	106	9	53	163	18	40
6.8	107	8	54	167	18	43
7.1	108	9	55	171	17	42
6.5	102	10	55	166	18	42
6.8	103	9	54	169	18	43
5.8	108	9	54	168	18	42
6.7	103	9	53	170	17	42
6.4	100	10	53	165	18	41
6.1	100	9	53	162	18	42
6.3	105	9	53	165	18	42
5.6	105	9	53	165	18	40

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GENERAL NOTES

Life History of a Ten-Year-Old Chimney Swift—Several years ago the writer published a detailed account of the life history of a ten-year-old female Chimney Swift (*Auk*, **73**: 276-280, 1956). Since then, another female Chimney Swift has completed ten years of life on the campus of Kent State University, in Kent, Ohio, and its life history is outlined here. The pattern is similar to the previous study, but there are many interesting variations.

This bird, wearing band no. 48-164510, will be referred to throughout this report as —10 for simplicity. This bird was banded as a juvenile in air shaft B1 on the roof of Kent Hall on August 4, 1949. Three other juveniles were banded at the same time and place, all being trapped with the parent birds which had nested in B1. However, these adults were not the parents of the newly banded juveniles, since their own offspring were at that time roosting at the bottom of the shaft where they had been living since their nest had fallen from the wall during a heavy rainstorm on July 31. (The survival of birds from fallen nests has been discussed by the writer in the following references: *Auk*, **69**: 289-293. 1952, and **77**: 352-354. 1960.)

No. —10 was retrapped as a return on May 18, 1950, from shaft A4 and was taken with another return, no. 48-164517, which will subsequently be designated as —17. These two soon moved into the adjoining shaft A5 where they remained for the nesting season. They started building on June 1. Five days later, they started a second nest foundation a few inches above the first one. After two more days, they constructed a third foundation beside the first one. The birds

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did not always roost on these nest foundations at night, contrary to custom, but frequently were on other walls of the shaft. No significant change was observed in the nest foundations until June 21, when one was found to be about half completed. It was finished June 25, but again the mates often ignored the nest during their evening roost. One egg was laid on June 28, which was considerably later than the average date for the appearance of the first egg. Two more were laid, and all three hatched successfully. However, on August 3 the nest was gone and the nestlings were at the bottom of the shaft where they were being attended by the parents. Two of the nestlings survived.

No. —10 was recaptured as a return on May 1, 1951, from shaft A5 where she was roosting with her mate of the previous year. In the evening of May 12, two other birds roosted with this pair and the following night one bird roosted with them. Soon, however, the mates were left by themselves and they began nest building on May 25. They completed the nest on June 2. The first egg appeared June 5. Two days later the second one appeared, and a third egg was laid on June 9. One of these disappeared on June 23. At this time the mates were captured for a simple experiment in homing. The male (—17) was taken to Canton (30 miles south) and released. The next day no. —10 was taken to Chesterland (30 miles north) and released. Both birds returned promptly to their nest. The two eggs hatched and nestlings with bluish pin feathers were observed on July 1. After nesting was completed, no. —10 roosted in shaft G4 with the mates of G4 and six other swifts. On August 3 no. —10 roosted in shaft E6 with the mates of that shaft and three other swifts. On August 11 no. —10 rooted in shaft U1 with 42 other swifts, and on October 2 no. —10 returned to G4, where she was one of the two remaining swifts on the campus for that year.

No. —10 was taken as a return on April 20, 1952, from shaft M7 with the male which had nested in that shaft the previous year. Nine days later, no. —10 was found back in shaft A5 where she had nested over the past two years. On that date she was alone, but the next night she and two others roosted together in shaft E1. One of the birds was banded at that time, but the third one escaped from the trap. On May 2 a flock of 37 swifts roosted in this shaft, including the former mate of no. —10, but she was not among this flock. However, on May 7 she and her former mate (no. —17) were back together again in shaft A5. They began nest building May 29, and the next day constructed a second foundation beside the first as they had done the previous year. That night each bird roosted on one of the foundations. This situation continued for several nights. They completed one foundation and laid the first egg on June 8. A heavy rain on June 14 destroyed the nest and two eggs. The mates deserted the shaft and were probably the birds which were seen in the adjoining shaft A4 following this date. On September 25 the A5 mates were found roosting in shaft G4.

On May 1, 1953, no. —10 was recaptured as a return from G4 with the male which formerly nested in G4 (42-188588). These two became mates in this shaft. They began nest building on May 23. The first egg did not appear until June 10. They laid a total of four. The mates were recaptured and three juveniles were banded on August 27.

The same pair was recaptured from G4 on May 11, 1954. On occasional evenings a visiting bird roosted with them for the evening. Nest building began May 28, and from that time on, a visitor remained with them until June 8. At that time the visitor obtained a mate of his own and entered shaft L3 for nesting. The first egg in G4 was found June 3, and two more were subsequently laid. On June 18, the former visitor returned after an unsuccessful attempt at nesting in shaft L3.

When swifts were first trapped (April 26) from shaft G4 in 1955, the former mate of no. —10 was taken with the female which formerly nested in shaft M7. Three days later, however, this female was back in M7 with her former mate of that shaft. A bird which then joined the male in shaft G4 was probably no. —10. This shaft was not trapped again until June 4, and at that time no. —10 was present with her mate of the past two years. The nest had been started on May 20, and two eggs were present at the time of trapping. The nest and eggs were accidentally destroyed during the trapping process. The mates continued to roost in this shaft during the night, however, and during the evening of June 8, a visitor remained with them for one night. On June 16 the pair started a second nest on

TABLE I

Summary of Life History of Female Chimney Swift 48-164510
at Kent, Ohio, 1949-1959 (Banded Aug. 4, 1949, in Air Shaft B1)

	Year									
	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Date of first capture each year	May 18	May 1	Apr. 20	May 1	May 11	June 3	May 17	June 3	May 27	May 16
Shaft used for nesting	A5	A5	A5	G4	G4	G4	G4	G4	G4	G4
Shafts used for roosting	A4 G4	G4 E6 U1	M7 E1 G4	—	—	—	—	—	—	—
Mate	48-164517	Same	Same	42-188588	Same	Same	48-164517 (Reunited)	Same	Same	48-166266
Number nesting together	2	2	2	2	3	2	2	3	2	2
Regular visitor during nesting	—	—	—	—	21-128602	—	—	21-194781	—	—
Date nest building began	June 1	May 25	May 29	May 23	May 28	May 20 June 16	June 5	May 25	June 4	May 24
Wall used for nesting	N	N	N	W	W	W	W	W	W	W
Distance nest placed from top (in feet)	9.4	10.3	10.3	13.3	13.5	13.5	13.6	13.5	13.0	13.5
Date first egg laid	June 28	June 5	June 9	June 10	June 3	May 31?	?	June 3	?	?
Number of eggs laid	3	2	2 destroyed	4	3	3	?	4	? ?	? 4
Number of juveniles produced	3	2	0	3	3	3	1	2	?	4
Occasional visitors during nesting	—	—	—	—	—	2	—	—	—	24-167735

the original site. The parents laid three eggs and raised the juveniles successfully. During the evening of July 27, two visitors roosted with this family. At this time, the nestlings were still on the nest. The next night there were three visitors. In the evening of August 6, eleven swifts spent the night in G4. These included the G4 parents, the H1 parents, the M7 female, two non-nesting birds (one of which had been a visitor in E1), an unbanded adult, and the three juveniles raised in G4. When this shaft was trapped again on September 25, no. —10 was still present, but her mate was not. With her at that time were the males from H1 and L1, and a nesting bird which had been the visitor in G4 in 1954.

When no. —10 was first recaptured in 1956, she was taken from shaft G4 with no. —17, her mate of 1950-52, and a visitor that had roosted in shaft G4 during 1955. The visitor soon left, however, and no. —10 and no. —17 were reunited as mates. They began nest building on June 5.

When no. —10 was first trapped in 1957, on June 3, she and her former mate already had a nest completed which contained one egg. With the mates was a visitor of the preceding fall season, which may possibly have been one of their own offspring. The three remained together through the nesting season. All three were x-rayed in an effort to determine if eggs could be detected in the oviduct, as a prospective means of sex determination. Results, however, were inconclusive, and the method did not seem to show promise. No. —10 laid an egg while in captivity on June 5. Subsequently she laid three others in the nest following her release. However, she successfully raised only two juveniles from these eggs. On September 21 the G4 mate and their visitor were seen roosting in their home shaft for the last time that season.

In 1958, a pair of birds took up residence in shaft G4, beginning on May 4. Later they were joined by another one that remained with them. On May 27, these three were trapped and found to be no. —10, no. —17 (her mate of the past two years), and an unbanded bird which was banded at that time. This visitor, however, soon left and nos. —10 and —17 continued to nest for another year in shaft G4. Nest building began June 4, but no details are available for that year since the writer was absent during the nesting season. The mates were last seen that year on October 4.

In 1959, two bird were found in shaft G4 beginning with May 2. One of these was recognized as a bird (48-166266) which had been trapped in shaft D1 on April 24, and in the meantime had roosted in shafts H1 and G3, before going to G4. His partner was determined to be no. —10, when the two were trapped on May 16. These two became mates for the season and started nesting on May 24. Four eggs were produced. In the evening of June 8, a visitor spent the night with them, but did not remain. However, this bird again spent the night with the G4 pair on June 20. The mates were last seen together in the evening of October 9. On October 12, no. —10 was alone in shaft G4, and that was the last record made for this bird. Details of her life history are reviewed in table 1.—Ralph W. Dexter, Dept. of Biology, Kent State University, Kent, Ohio.

Mist Netting in Hamilton County, Ohio.—On August 29, 1960, a small concentration of warblers and other migrants—flycatchers, vireos, etc.—was found in a wooded area in a southern section of Wyoming, Hamilton Co., Ohio. No other migrants of these families had been seen up to this date, and none were reported outside this 12-15 acre tract until September 10 in another part of the county. This area had a heavy infestation of "inch" worms and tent caterpillars. For a further description of the tract see *Audubon Field Notes* **11**: 453, 1957; **12**: 453-454, 1958; **13**: 471-472, 1959.

On August 31, 300 feet of mist netting, from 7-10 feet in width and set 2-4 feet above the ground, were strung along a ridge running through a second growth woodland. The nets covered 2,460 square feet. The nets were manned on 1, 3, 4, and 6 of September, also. A total of 35 man-hours was spent by the writer on the project, and the hours varied within the limits of 4:00 A.M. to 7:30 P.M., EST.

Summary of banding: Forty-three warblers and vireos were trapped and banded; there were 39 retraps involving 26 individuals. The species banded were: Blackburnian Warbler, 22; Black-and-white Warbler, 6; Chestnut-sided Warbler, 5; Magnolia Warbler, 3; Red-eyed Vireo, 2; Bay-breasted Warbler, 2; one each of

A Black-and-white Warbler before being extricated from the mist netting. Photo by Karl H. Maslowski.

Tennessee Warbler, Ovenbird, and American Redstart. Forty-four individuals of "permanent resident" species were banded and 22 birds were retrapped for a total of 38 times. Those considered as local residents were Downy Woodpecker, Carolina Chickadee, Tufted Titmouse, Carolina Wren, and Cardinal. These are species which move very little from one area to another through the seasons as shown by banding returns.

This operation indicates that half of the migrating warblers actually remained for one or more days. (Twenty-one birds were retrapped after a lapse of 40 hours or more from the previous capture.) About the same percentage of repeats was noted for both the migrants and local residents, indicating that both were caught

during the period of netting indiscriminately and each was static. By September 13 the inch-worm infestation had subsided and the warblers began to diminish in number. It was estimated that no more than 65 warblers and vireos were present at any one time during the trapping period; therefore, a rather high percentage of the migrants was secured. Twenty-two individuals of 13 other species were caught also, but repeats proved to be unimportant.

The writer has no official weather data for the period, but his personal notes report "temperature high (70°-98°); relative humidity also very high; partly cloudy to clear; wind NW-ENE, average NNW, calm to 8 mph; no noticeable precipitation."

In this banding operation the writer was assisted by many persons, notably Worth S. Randle, who also helped immeasurably in the writing of this paper; Richard E. Watkins, and Paul W. Woodward, all of Cincinnati. The photo is supplied through the courtesy of Karl H. Maslowski and was taken at the trapping site.—Jay M. Sheppard, Department of Zoology, Miami University, Oxford, Ohio.

Mourning Dove Banded in Massachusetts in Winter, Taken in Florida.—The following recovery record is of interest, mostly because it defies interpretation in any known framework in my experience. On February 9, 1958, an adult Mourning Dove was banded at Arcadia Wildlife Sanctuary, Northampton, Massachusetts, coordinates 4217-7238, with band 533-22635. On January 7, 1961, this bird was shot in Hillsborough County, near Lake and Orange Grove, near Tampa, Florida. It was reported to the F. & W. Service by Mr. H. L. Gardner of Tampa.

Obviously there is the hint here that Mourning Doves wintering in the northern states, still may end up being shot in a southern state. Also, obviously, many more doves must be banded by northern banders, and recoveries from them reported, before we begin to get the proper picture of what is happening with regard to the continental dove population. Banders should comply with the Service's request to band just as many Mourning Doves as possible.—Edwin A. Mason, Arcadia Wildlife Sanctuary, Northampton, Massachusetts.

More Connecticut Starlings.—The note in the January issue *(Bird-Banding*, **32**: 57-58) prompts a listing of the Starling recoveries from the 69 birds I mist-netted at the State Prison Farm in Somers, Conn. (about 16 miles NNE of Hartford) in the summer (dates in international order):

Band Number	Age	Date Banded	Recovered Date	Place Recoverd
502-39903	1	18/7/57	11/3/58	Springfield, Mass. (about 10 or 12 miles NNW)
909	A	18/7/57	11/5/59	Hartford, Conn. (about 16 miles SSW)
946	1	8/8/57	27/1/59	Hanover Watershed, Bandanna, York Co., Pa. (about 250 miles SW)
947	1	8/8/57	19/11/60	East Springfield, Mass. (about 12 miles north)

Three of the birds were "found dead," but —946 was trapped and released. This bird was part of the very large flocks roosting in the municipal watershed, in which the U.S. Fish and Wildlife Service has been experimenting with trapping techniques. The dates on which the other birds were found dead do not rule out the possibility that they too were summer residents rather than permanent residents.—Mary Heimerdinger, Dept. of Invertebrate Zoology, Peabody Museum of Natural History, New Haven, Conn.

RECENT LITERATURE
BANDING

(See also nos. 4, 5, 17, 37)

1. The activities at Ottenby Bird Station 1959. Report 28. (Verksamheten vid Ottenby fågelstation 1959. (Meddelande nr 28 från Ottenby fågelstation).) Anna Tolstoy. 1960. *Vår Fågelvärd*, **19**: 292: 315. (English summary.) Banding was carried out from 5 April to 31 October. A total of 11,295 birds were banded. Nineteen species set new records in the number of birds captured. Recoveries totalled 204 of 49 species, including retakes at Ottenby, and 4 foreign recoveries were trapped and released. A Firecrest *(Regulus ignicapillus)* and an Alpine Accentor *(Prunella collaris)* were caught on the same day, 2 May. The prolonged migration of these two southern species, both new for Sweden, was apparently temperature-dependent and due to the combination of high barometric pressure over Russia with a break-through of warm air over these birds' breeding-grounds. Two maps show all the recoveries of Song Thrushes *(Turdus ericetorum)* and Black-headed Gulls *(Larus ridibundus)* banded at Ottenby. In this report is also included highlights from the resident game-warden's all-year records.—Louise de K. Lawrence.

2. Report from Russia on Banded Snow Geese. [Chester E. Kebbe.] 1961. *Bull. Ore. State Game Comm.*, **16**(2): 4-5. Three *Chen hyperborea* banded on July 18, 1960, at Wrangel Island were shot at Summer Lake in south-central Oregon on October 27, October 29 and November 4, 1960. A previously published note in this magazine states that all three birds were young of the year. —J. J. Hickey.

MIGRATION

3. The time of imprinting to the home region in the Collared Flycatcher *(F. albicollis)*. H. Löhrl. Zur Frage des Zeitpunktes einer Prägung auf die Heimatregion beim Halbandschnapper *(Ficedula albicollis)*. 1959. *Journal für Ornithologie*, **100**(2): 132-140. The term "imprinting" most commonly evokes a picture of goslings following a man or of real ducklings trailing in the wake of a mechanical Mallard; and it is sometimes defined as the rapid formation of stable primary stimulus-response associations *during early infancy*. But the tendency has been growing to broaden the concept to include locality-fixations acquired at specified times later in the development of the individual. In this sense imprinting has a profound bearing on bird migration. And this is the sense in which Löhrl writes of it.

He raised nestling Collared Flycatchers by hand and let them fledge in outdoor flight cages. When they had become self-supporting, he set them free 90 km. to the south, at Sigmaringen on the other side of the Alps in a region where the species does not occur. In the first test, 19 percent of the males (compared with a 4 percent return in natural populations) came back to the extralimital district of release next spring. He turned a second group loose about 2 weeks before the beginning of fall migration. A similar percentage of these returned to Sigmaringen the following year to nest. He held a third group until the end of the postjuvenal molt, after the migration of the species had already begun. None of these birds was ever seen again. Löhrl concludes that juvenile flycatchers become imprinted to the place where they happen to spend the 2 weeks just prior to migratory departure. The rate of return was much poorer for females than for males. The greater difficulty in recording females of the species partly accounts for this result, but the fact that many of the male Collared Flycatchers returning to Sigmaringen took Pied Flycatchers as mates suggests that actually few female Collared Flycatchers were present.

These findings are related to the question whether or not the young of the year of certain species find their way back to the breeding range on their first spring migration by true goal orientation. Löhrl's work explains why, even if this were the case, so few would come back to their exact birthplace to compete with their own parents for nesting territory or to inbreed if only one of the

parents had survived. But as proof of goal orientation, the experiments are inconclusive. If young birds have a way of maintaining, or continually returning to, a "standard track" (a straight-line projection of standard direction onto the terrain), they could retrace their way in spring to the locality where their fall migration began simply by following the standard track in reverse, without recourse to bicoordinate navigation. Löhrl's third group of experimentals spent the postulated imprinting period in their natal district. According to hypothesis, they should have reappeared there in the spring. Yet evidence is lacking that any did. To be sure, the situation at their natal locality is unfavorable for ready detection; but even so the probability that as many found the real home again as found the foster home seems remote.—R. J. Newman.

4. Migrational homing in Mourning Doves. Stanley W. Harris. 1961. *Journal of Wildlife Management*, **25**(1): 61-65. We Americans have all become accustomed to the basic idea of "locality imprinting." We have heard again and again of birds returning year after year to the same nesting box. But how prevalent is this custom? How many other individuals of the same species vary their nesting sites? The majority or the minority? The exaltation of positive over negative evidence has obscured the answers.

Now Harris brings us a nicely balanced report on the return and non-return of nested-trapped Mourning Doves to a 160-acre tract in Minnesota during a 3-year study. In computing adjusted rates of return, he applies a mortality rate of 51 percent for adults and 60 percent for nestlings and assumes that the total number of birds returning (the unknown) is to the total population in the study area as the number of banded birds trapped is to the total number of birds trapped. According to his calculations, nearly all the adult males still alive, and 59 percent of the adult females, came back to the area one year after banding. Smaller samples suggest that 2 years after banding all survivors of both sexes returned. In contrast, the rate for birds banded as nestlings was on the order of only 2 percent for the first 2 years, zero for the 3rd year. The average shift of banded adults from their first recorded nesting location was a mere 154 feet 1 year later, 300 feet 2 years later.

The results seem capable of two interpretations: either all survivors that have nested twice in a locality return there a third time or else all 3-year-olds return to the locality where they nested the second time. Neither alternative reconciles a 59 percent return of female survivors one year after banding with a 100 percent return a year later. One may appreciate the dilemma simply by noting that, with an adult mortality of 51 percent, 49 percent of the adult females banded in the first year of the study must have been more than one year old. If the second alternative is accepted (that 100 percent of the survivors of the 49 percent returned), then the over-all return of 59 percent requires that only about 12 percent of the surviving first-nesters returned. The first alternative is mathematically more complex. It requires that roughly only 45 percent of the survivors that nested once in the area came back again. But both assumptions produce an expected return in the second year after banding much lower than the observed return as adjusted.

Harris himself is cautious in his claims. He admits that his assumptions may be inaccurate and that the small quantity of his data permits statistical error. He is not even completely convinced that the computed difference in the rates of the sexes is real, though the result accords with the experience or Löhrl with female Collared Flycatchers (see preceding review). While his work is a significant stride forward, it leaves many uncertainties to be resolved by further investigation on a larger or longer-continued scale, using this study as a prototype.—R. J. Newman.

5. Northern Waterthrush returning to same winter quarters in successive winters. D. W. Snow and B. K. Snow. 1960. *Auk*, **77**(2): 351-352. A bird mist-netted in Trinidad in December 1958 was recaptured in December 1959 in a net at the same location, in the identical position. Though the record is a welcome additional evidence of "locality imprinting" to tropical wintering grounds, it is not quite so lacking in precedent as the authors believe. In a subsequent note (*Auk*, **78**: 123), William B. Robertson has called attention to previous examples, involving other species, in Guatemala, Africa, and India. —R. J. Newman.

6. Evolutionary aspects of migration. George G. Williams. 1958? *Lida Scott Brown Lectures in Ornithology*. This paper poses a bibliographic conundrum. It is the second of two lectures delivered by Dr. Williams in 1958 at the University of California at Los Angeles, published together in one binding at an unspecified later date under a dual title and uncertain auspices, and mailed, presumably fresh from the press, to the reviewer in 1960. This second lecture occupies pp. 51-85 of the publication.

Its central thesis is that "in the normal evolution of a migration pattern, the winter home must be considered as the original point of departure." Williams refreshes this long-standing contention by attempts to link it with a process he calls "locality fixation" and defines as "the establishment in a bird's early life of a strong attachment for a locality and the persistence of this attachment into adult life." Though presumably unaware of the work of Löhrl, he presciently suggests that locality fixation may be related to, or even identical with, imprinting. The speculation eventually leads to dilemma.

All migrants returning to the breeding range in spring are potentially imprinted to localities within, or adjacent to, that range. Among the migrants setting out for the winter range in fall, little more than one-half have that advantage. Since locality-imprinting results from personal experience with the locality even by Williams' own definition, the young of the year cannot yet be imprinted to the winter range. Williams speculates that adults already fixated on the proper goal may transmit their knowledge to the new generation through the nongenetic medium of tradition—that the old since time immemorial have guided the young to the appropriate winter range. Aware of many cases in which there is evidence to the contrary, he is forced to make use of such contradictory combinations as inheritable locality-fixation and innate tradition.

Actually, the principle of imprinting forges a more constant bond between birds and their ancestral breeding range than between birds and their ancestral wintering grounds. Locality imprinting gives the breeding range theoretic primacy over the wintering range in the contemporary evolution of migration patterns. Extensions of breeding range nowadays appear to have a permanence that most independent extensions of wintering range seem to lack. Whether or not imprinting is reversible is a question for ethologists to decide, but Williams errs when he says "if locality-fixation were 'totally irreversible,' birds would never expand their ranges." Löhrl has shown that a period intervenes between the time when young leave the nest and the time when they become locality-imprinted. During this interval, they are free to wander at random. Birds hatched at the periphery of the previous range are as likely to become imprinted to localities outside it as to localities within it.

The evolutionary relationships between breeding ranges and wintering ranges today are not necessarily the same as in the past. But at a time when migration students cannot agree on the current realities of their subject, controversy over what may have happened long ago seems like sparring in a vacuum. Williams makes many points to establish his main theme. Yet all could be turned about by a different selection of examples. Certainly the viewpoints that migration is a return to an ancestral home in the north or to an ancestral home in the south are not mutually exclusive. To cite evidence in support of one is not to disprove the other.—R. J. Newman.

7. Migration across the sea. David Lack. 1959. *Ibis*, **101**(3-4): 374-399. To a degree Dr. Lack shares Dr. Williams' liking for a firm stand in the absence of conclusive evidence. He prefaces his distillation of 142 references regarding transmarine migration with the confession: "faced with the alternative between a neutral, and hence colourless, survey and the statement of positive views on incomplete evidence, I have preferred the latter method as the more likely to advance research . . ." The reviewer does not entirely agree that the clash of opposing hypotheses, objectively stated, lacks color or that this clash is less likely to stimulate further investigation than argumentative efforts to decide an issue. Happily, however, Lack's positive views are mainly centered on a single aspect of the subject—the controversy regarding the nature of migrational drift.

The survey calls attention to world-wide feats of birds crossing over water: the flight of 16 Australian species northward 600 miles across the Banda Sea; 1,600-mile journeys of land birds across the Indian Ocean, from western India to East Africa; sea-crossings of perhaps as much as 1800 miles by two New Zealand

cuckoos that winter in the Solomons, Samoa, and the Fijis; and movements of Wheatears from Greenland to Britain and the Iberian Peninsula, respectively requiring a traverse of 1400 and 2000 miles over the Atlantic. Discussion naturally focuses, however, on the observations concerning three long-studied appurtenances of the world's oceans, each with different relationships of land and water—the Gulf of Mexico, the Mediterranean, and the North Sea.

Lack accepts the reality of trans-Gulf migration, questions special concentration of spring migrants in the Yucatan Peninsula, and suggests that some passerines may undertake the 1000-mile crossing from Honduras direct to the United States. The data of the latter 1950's on the "trans-Gulf Timetable" and the diurnal passage of migrants over the Gulf, so far buried beneath general titles, have understandably escaped his notice. He notes that trans-Mediterranean migration bears the distinctive stamp of a presumed "migratory divide." Banding results suggest that the direction taken by most North European night migrants in autumn is either southwest or southeast, rather than south, with resultant concentration at the two ends of the Mediterranean. Lack is not entirely satisfied that the dichotomy is real, that it is anything more than an illusion created by differing facilities for banding recoveries. He further reasons that, even if such a division actually occurs, it does not necessarily indicate a preference for short crossings. He believes that the split may be due to ecological or meteorological factors, or perhaps even in part to historical ones. The evolutionary aspects of trans-Mediterranean migration and the migratory divide have facets that Williams, preoccupied with New World problems, did not explore. Banding results are to some extent countered by general observations indicating that flight across the Mediterranean takes place on a broad front.

The North Sea differs from the Gulf of Mexico and the Mediterranean in that bird movements across it are not necessarily intercontinental. There the role of drift, unmentioned by Lack with respect to the Gulf and only fleetingly referred to with regard to the Mediterranean, has attracted great attention. Though the present paper devotes more space to migration over the North Sea than to any other single topic, comment is best deferred. The publications about to be reviewed explore the subject in even greater detail.—R. J. Newman.

8. Migration across the North Sea studied by radar: Part 2, the spring departure 1956-1959. David Lack. 1960. *Ibis*, **102**(1): 26-57. Few research reports on migration have ever been so packed with conclusions as this one. It bases its judgments on the enormous amount of data accumulated by radar during nearly continuous operation in four springs and lists these data in exemplary fashion in the fine print of its appendix.

Lack is here dealing primarily with spring emigration from East Anglia; he does not imply that all his findings are true of bird migration in general. He states that the movement in question occurs most frequently in large "volume" in the first half of the night, with light winds, and after delays due to early subnormal cold. The movement does not ordinarily start when there is snow, rain, or fully overcast sky. Its density is little affected by the direction of the wind, sudden changes in temperature, or unsettled weather in general. The number of birds over the sea usually peaks between 9 and 10 p.m.; the overland maximum presumably occurs earlier. After being pinned down for long periods by unfavorable conditions, normally nocturnal migrants tend to travel also by day. Occasionally their movement starts in mid-afternoon; more rarely they stay aloft as long as 30 hours. Once spring emigration gets under way, it usually proceeds steadily night after night, without pronounced "waves" separated by long gaps during which only negligible migration is evident. The tracks of the birds, evaluated according to the presumptive wind forces exerted on them, commonly support the hypothesis of lateral drift and more rarely suggest disoriented drift. They never point to direct downwind drift.

How reliable, actually, is the radar evidence? While Lack has previously discussed this matter in considerable detail, some points remain unsatisfactorily resolved. The equipment used compresses a view of more than 33,000 square miles of the earth's surface into the frame of a 35 mm. photograph. Obviously the migrants flying over so vast an area cannot all show up as discrete entities. When the density of birds reaches a certain point, of unknown numerical value, the echoes of those at close range merge in a continuous mass. Farther from the

station the echoes gradually thin out. At intermediate ranges their number and direction of movement become easier to ascertain. The effect is presumably due to the progressive failure of radar to detect birds at the greater distances; and since this failure seems to be selective, the possibility exists that studies by long-range radar deal mainly with the behavior of migrants of special types.

Under these circumstances, the problem of quantifying migration from a radar display accurately, even in relative terms, appears formidably complex. Lack classifies the amount of migration in five grades numbered from 0 (negligible) to 4 (huge). An important consideration is whether this classification forms a linear scale, in which the actual quantities of birds represented have approximately the numerical relations of their class numbers. If the real difference between grade 1 and grade 2, for example, were much smaller than the real difference between grade 3 and grade 4, erroneous conclusions would be likely to result—particularly since the mathematical soundness of averaging class numbers would be dubious.

Consequently when radar evidence conflicts with other evidence, one cannot as yet be sure what to believe. A fuller explanation of the procedure used to classify the quantity of migration on the basis of radar photographs would be helpful to investigators employing other bases, but would not eliminate perplexities caused by a saturation of echoes and by the selective tendencies of the set at long ranges.—R. J. Newman.

10. Aspects of autumn migration, 1960. Kenneth Williamson. 1961. *Bird Migration*, **1**(5): 218-234. "Aspects" in its various datings seems to be a regularly planned feature of the new journal *Bird Migration*. Its content is diverse, but its presentation is dominated by a point of view quite unlike that reiterated by Lack. Williamson continues to correlate observed ornithological and meteorological phenomena in terms of direct downwind drift. His success along this line would be thoroughly convincing to the casual onlooker, had not so much opposing argument already appeared in print.

A primary reason why neither faction can effectively demolish the other is uncertainty regarding the point of origin of a given flight of continental migrants to Britain. Williamson, who has confidence in rare birds as markers—a confidence Lack does not share—emphasizes the "heavy influx" of Barred Warblers *(Sylvia nisoria)* early last autumn. Since this species does not breed in Norway, Williamson holds that the flights in which it was represented must have come mainly from Denmark and northwest Germany, where a southwest breeze favored downward drift, while light southwest wind in Scandinavia was precluding lateral drift from the latter source. Not until the effective area for downwind drift extended into Norway did Redstarts *(Phoenicurus phoenicurus)* begin to appear in the British Isles.

Other occurrences discussed by Williamson are reversed migrations from France "inexplicable except as a down-wind movement," immigrations of the Firecrest *(Regulus ignicapillus)*, which "shows a marked down-wind influence in its arrival," and a disaster at sea that caused numbers of Redwings *(Turdus musicus)* to be washed up on shore. The only American passerine that appeared in Britain during the period was a Myrtle Warbler *(Dendroica coronata)*.—R. J. Newman.

11. Observations from a light-vessel on passerine immigration into the Wash in autumn 1956. Michael Barry. 1960. *British Birds*, **53**(10): 435-443. The Wash is a broad arm of the North Sea that indents the east coast of England. Observations from a lightship at the mouth of this inlet on 16 October 1956 conflicted with previous reports from the same location by showing that the incoming migration of Lapwings, Skylarks, Starlings, and Chaffinches was mainly southwestward. Barry considers these flights a visible version of direct influxes from Scandinavia such as detected by Lack on the radar screen. However, with a change in wind from southwest to south-southeast, the directions of flight shifted more to the south, counter to the expected trend if the birds were holding a fixed heading. The paper also gives various observations for other dates and other species.—R. J. Newman.

12. Autumn migrants in Greece. R. E. Moreau. 1960. *Ibis*, **102**(3): 473-475. During a stay of nearly a month on the mainland of Greece in September and October, 1959, Moreau found surprisingly few migrants. Even Swallows

(Hirundo rustica) were sporadic, but on 8 October they loaded the wires along Navarino Bay. Toward dusk on the same day an observer on the coast of Cyrenaica, 350 miles to the south on the opposite side of the Mediterranean, noticed large flocks loosely distributed over a 3-mile front coming in from the sea. During the night the winds changed from light westerly to southerly with gale force, but all next morning Swallows continued to arrive in fairly large numbers though singly. Moreau believes that these latter birds had been crossing the sea all night. —R. J. Newman.

13. Notes on autumn migration in Greece and Crete. Richard Vaughan. 1960. *Ibis*, **102**(1): 87-92. The ovservations were made on the Peloponnesos and the islands of Paros, Kythera, and Crete, 15 August to 13 September 1958. Though worthy of note because so little information is available from these key locations, they are scattered and incidental and, like the data of Moreau (see preceding review), fail to demonstrate much large-scale migration across this part of the Mediterranean.—R. J. Newman.

14. The passage of Palaearctic migrants through Eritrea. K. D. Smith. 1960. *Ibis*, **102**(4): 536-544. Eritrea is situated on the lower west shore of the Red Sea, at the southern edge of the African desert belt. Most Eurasian migrants passing directly toward that country or directly away from it must cross a vast expanse of uninhabitable terrain.

The circumstances lend special interest to Smith's observations during his many years' residence in that part of Africa. He lists in separate categories birds seen migrating there: (1) conspicuously on both spring and autumn passage, 37 species; (2) more abundantly in autumn, 23 species; (3) more abundantly in spring, 11 species; (4) in neither season, though common winter residents, 24 species. The reasons for the greater volume of migration in fall, and for the arrival of southbound migrants on dates that would be considered early even in western Palaearctic regions, are only partly explainable.—R. J. Newman.

15. Ticks from European-Asiatic birds migrating through Egypt into Africa. Harry Hoogstraal and Makrum N. Kaiser. *Science*, **133**(3448): 277-278. The authors examined 8,379 bird specimens. They found 504 immature European-Asiatic ticks. The hosts included 28 of the 57 migratory species studied. Among the ticks recovered were *Hyalomma m. marginatum* and *Haemaphysalis punctata*, vectors of pathogens causing diseases in domestic animals and associated with such human diseases as Crimean hemorrhagic fever, Q fever, tularemia, tick typhus, and brucellosis. Findings such as these give bird migration considerable epedemiological importance.—R. J. Newman.

16. Migratory birds and the dispersal of avian malaria parasites in the South Pacific. Marshall Laird. 1960. *Canadian Journal of Zoology*, **38** (1): 153-155. The report reveals that the Shining Cuckoo *(Chalcites l. lucidus)* and the Broad-billed Flycatcher *(Myiagra f. ferrocyanea)* are hosts of *Plasmodium relictum*. The cuckoo provides the second known illustration of a natural means for the dispersal of avian haematozoa into New Zealand.—R. L. Newman.

17. Ringing recoveries and the interpretation of bird-movements. Kenneth Williamson and Robert Spencer. 1960. *Bird Migration*, **1**(4): 176-181. Abroad, as in the United States and Canada, the mist net is providing new opportunities to study the migrations of small birds. In 1959-60, banders in the British Isles secured enough data to permit studies of the particular bird movements of a single year and even rough correlations with weather. Seed-eaters, which enjoyed an unusually good summer in 1959, furnished the most material.

Twenty-six of the Linnets *(Carduelis cannabina)* banded in Britain in 1959 were recovered on the continent, all but one of them tightly grouped in the main wintering area of their population, an area much smaller than the range from which they came. The 10 continental recoveries of the European Goldfinch *(Carduelis carduelis)* outnumbered such recoveries in all other years combined but were similar to the previous distribution. Even House Sparrows *(Passer domesticus)* displayed unusual movement; for the first time in history an individual banded in Britain was recorded across the English Channel. A European

Robin *(Erithacus rubecula)* banded in Suffolk in October was recovered in the Shetland Islands in the following April. The authors regard it as a continental migrant that drifted to Britain during both autumn and spring passage. Other species mentioned are *Carduelis flammea* (dramatically on the move in America in the same year) and *Chloris chloris.*

An arresting feature among several of these examples is a convergence from the banding locations to less widely spread points of recovery. One might conclude that not all members of British populations of a species fly in the same standard direction. However, if banding stations in Britain are more homogeneously distributed than recovery facilities on the continent, appearances may be deceiving.—R. J. Newman.

18. Ground-speed and air-speed according to flock-size in migrating birds. (With Danish summary). N. O. Preuss. 1960. *Dansk Ornithologisk Forenings Tidsskrift,* **54**(3): 136-143. Seventy-one flocks of migrating Oystercatchers *(Haematopus ostralegus),* timed over a measured kilometer in Denmark, passed at air speeds of 21 to 40 mph. As in previous studies with other birds, they flew higher with fair winds than with head winds. A plotting of the number of birds per flock against ground speed indicates that the bigger a flock, the faster it travels. But when Preuss made a linear regression analysis using air speeds, the relationship was much less pronounced and without statistical significance.

The greater correlation between ground speed and flock size than between air speed and flock size suggests to the reviewer that the original influence may have been stated backwards. Perhaps we should not be asking whether bigger flocks fly faster than small ones but whether birds tend to fly in larger flocks when the wind direction is favorable for fast passage than when it is unfavorable. In the present investigation the angle of the wind to the direction of the birds varied only from 50 degrees to 100 degrees and therefore did not show what would happen with real head winds or real tail winds.—R. J. Newman.

19. Goose emigration at the Butt of Lewis. A. MacEachern and K. Williamson. 1960. *Bird Migration,* **1**(4): 182. The general pattern of spring movement was much as in previous years. The majority of the geese waited for anticyclonic weather and passed in the fourth week of April. The first three days of May brought *southward* movements of Gray Lag Geese, possibly because of deteriorating conditions to the north.—R. J. Newman.

20. Migration of the Sandhill Crane east of the Mississippi. Lawrence H. Walkinshaw. 1960. *Wilson Bulletin,* **72**(4): 358-384. In this careful study by a specialist on the species, documentive data ond citations each occupy more space than the text proper. Walkinshaw postulates three migration paths for Sandhill Cranes. Here he centers his attention on the easternmost, a northwest-southeast flight that mainly passes somewhat west of a line drawn from James Bay to eastern Georgia and presumably connects with a main wintering range in Florida. On its western side also, this flight zone seems clearly bounded. Relatively few migrating Sandhills have been reported from western Illinois, western Kentucky, or western Tennessee; none at all have been noted in Mississippi or Alabama. A map of the eastern United States with plotted points of observation shows several vacant stretches and stretches with infrequent records along the way. That such gaps can occur in the case of a bird as large and conspicuous as a crane should give pause to students of migrating passerines who are prone to draw far-reaching conclusions from an absence of records.—R. J. Newman.

21. Bird-migration terms. A. Landsborough Thompson. 1960. *Ibis,* **102**(1): 140. This letter objects to the Lack and Williamson translation of the German *Leitlinie* as "diversion-line." Thompson feels that "diversion-line" has implications that sometimes may be of dubious validity—a point the reviewer has already sought to suggest *(Bird-Banding,* **31**(1): Review 2). That *Leitlinien* always divert seems a conclusion not yet wholly warranted. Thompson recommends returning to the rendering "leading line," a term he considers properly neutral since migrants can be "led" astray as well as in the right direction. A more obviously neutral alternative sometimes used by the reviewer is simply "line of influence."—R. J. Newman.

22. Migrants at airport ceilometers. Margaret B. Hickey. 1960. *Passenger Pigeon*, **22**(1): 23-26. Eastern Kingbirds and other passerines, along with Green Herons and Black Terns, swarmed spectacularly through a ceilometer beam at Madison, Wisconsin, between 10:30 and 11:45 PM on the night of 23 May, 1952. By 1 AM the numbers had decreased approximately 50 per cent. No known mortality occurred. Next night fewer birds were in the beam, though they circled longer there and 15 of them were subsequently found dead. The specimens picked up from the grass showed no signs of injury. Seven years later —during the hour prior to 1 AM, 4 October 1959—migrants again appeared in the beam. The subsequent casualty list this time included 117 birds of 24 species, all passerine. Why birds attracted to ceilometers die on some occasions but not on others still awaits satisfactory explanation. As more and more reports like the present one become available, they may eventually suggest a reasonable working hypothesis.

Mrs. Hickey makes a challenging point. There had been no clear skies between Madison and the Canadian border for two days preceding the 1959 disaster. If her information is correct, the birds concerned must have taken wing without a clear view of sun or stars, in defiance of the opinion of some investigators that they never do so.—R. J. Newman.

NIDIFICATION AND REPRODUCTION

(See also nos. 24, 30, 39, 40)

23. Cowbird Hosts in Southern Quebec. Lewis McIver Terrill. 1961. *Canadian Field-Naturalist*, **75**(1): 2-11. A remarkable record, covering 53 years, in which 390 parasitized nests were found among 4,452 occupied nests of 42 host species. This amounts to 8.8 percent, a low figure in comparison to observations in Michigan —22.4 percent (Berger, 1951), Pennsylvania —30.7 percent (Norris, 1947), and Ohio—31.2 percent (Hicks, 1934). A few samples will be quoted from the author's annotated list: Phoebe *(Sayornis phoebe)*, 26 percent of 108 nests; Red-eyed Vireo *(Vireo olivaceus)* 42 percent of 64 nests; Song Sparrows *(Melospiza melodia)* only 12.7 percent of 486 nests, in contrast to two Ohio records—34 percent (Hicks) and 43.9 percent (Nice, 1937). Little information was found on the success of the nests. The author states: "In Quebec the fledging of even one host young per nest amongst the smaller passerines is notable. More often there are no survivors." One correction: my observations on *Molothrus ater* and Song Sparrows were made in Ohio, not in Oklahoma, a state in which the latter does not nest.—M. M. Nice.

BEHAVIOR

(See also no. 3)

24. The Comparative Ethology of the African Parrot Genus *Agapornis*. William C. Dilger. 1960. *Zeitschrift für Tierpsychologie*, **17**(6): 649-685. This is a detailed study of eight species and subspecies of a small parrot averaging from 28 to 58 grams in weight, the females weighing slightly more than the males. The author traces "the gradual loss and acquisition of various behavioral and morphological characters" from the most primitive form *cana* to the most recently evolved *personata nigrigenis*. Among the 11 trends listed are loss of sexual dichromatism, development of increasing socialization, increase in complexity of nests, and loss of reciprocal courtship feeding. One species—*A. pullaria*—usually sleeps hanging upside down, as do all species of *Loriculus*.

Agapornis is noted for the remarkable behavior of some of its species in tucking nest materials in its feathers and carrying them in this manner to its nest. "Females of *cana*, *taranta*, and *pullaria* bite off very small pieces of nesting material and carry them, many pieces at a time, thrust amidst the feathers of the entire body. The entire plumage is ruffled as if to receive such material every time a piece is being placed in the feathers. The feathers are compressed again during each bout of cutting the next piece . . . *A. taranta* has the unique habit

of also utilizing its own feathers as nest material." *A. roseicollis* females cut larger strips of material than the first three species; erect only the feathers of the lower back and rump meanwhile and tuck the pieces only into these feathers. The four subspecies of *personata* carry nest material only in their bills.

This comprehensive study is illustrated with many photographs including a plate in color of all eight forms of *Agapornis* involved.—M. M. Nice.

25. The Recognition of Birds of Prey, Especially the Sparrow Hawk and Hobby, by Small Birds. (Zum Erkennen von Raubvögeln, inbesondere von Sperber und Baumfalk, durch Kleinvögel.) Hermann Mohr. 1960. *Zeitschrift für Tierpsychologie*, **17** (6): 686-699. Summary in English.) During the breeding season Barn Swallows *(Hirundo rustica)* and House Martins *(Delichon urbica)* regularly mobbed Sparrow Hawks *(Accipiter nisus)* and Hobbies *(Falco subbuteo)*. They pursued the former with loud cries but tended rather to flee from the latter. "Following prolonged absence of a releasing stimulus, the swallows perform mobbing of a predatory bird as a vacuum activity."

Experiments with perched dummies showed that the swallows' "recognition scheme for a bird of prey requires that the object be three-dimensional, inconspicuously (not brightly) colored, and with a hooked beak." The most effective model was middle-sized with yellow eyes corresponding to a Sparrow Hawk. A hen turkey leading her poults warned at the appearance of a flying bird of prey long before it was visible to the human eye; she ignored a downy young pigeon in the hands of the author but when he carried a downy young Sparrow Hawk with dark eyes, recognizable only as a bird of prey by its beak, she sprang at it fiercely.—M. M. Nice.

26. The Development of Some Behavior Patterns of Hand-Raised Sparrow Hawks and Hobbies. (Ueber die Entwicklung einiger Verhaltenweisen bei handaufgezogenen Sperbern (*Accipiter n. nisus* L.) und Baumfalken (*Falco s. subbuteo* L.).) Hermann Mohr. 1960. *Zeitschrift für Tierpsychologie*, **17**(6): 700-727. (With English summary.) With both the *Accipiter* and the falcon any pointed or small red object at the level of the eyes or above served as a releaser for taking food. From 8 days on the nestling also begs from the parent or foster-parent. The Sparrow Hawks seized moving objects at 5 weeks of age, but took no interest in insects. The first attempts of the Hobbies were all directed towards the capture of insects, and only after 6 months did they show interest in living birds.

The nestlings of both species were peaceable together; indeed, if the Sparrow Hawks were not, no male would ever be raised. The large female of this species takes prey larger than herself, but the male, about half her size, kills only birds smaller than himself.

"Except in the breeding season Sparrow Hawks show no attraction to conspecifics and scarcely any inhibition to killing them. Before the beginning of breeding, the female stops hunting and is supplied with food by the male."

Sparrow Hawks taken from the nest before the age of 9 days became imprinted on human beings as parents and as sex partners. "The parent is recognized as to species, the sex partner individually." One female courted the author in her first and second spring, building a nest both years, laying eggs and incubating for 8 weeks the second year. She accepted a baby domestic chick and brooded it for a day after which time the author gave it back to its mother; it was yellow in color and peeped much like a newly-hatched Sparrow Hawk. A very interesting article.—M. M. Nice.

27. The Relation of Hormones to the Reproductive Behaviour of Birds, Referring Particularly to Parental Behaviour: a Review. Erica Eisner. 1960. *Animal Behaviour*, **8**: 155-178. A comprehensive summary of the subject including references to studies on mammals. Among other subjects there is a valuable discussion of brood patches. "In non-passerines there appears to be a good correlation between the development of patches and participation in incubation." Yet within the Passeres in some species males incubate but do not develop patches. In the author's Bengalese Finches *(Lonchura striata)* both parents incubate intensively, yet neither sex shows any suggestion of vascularization or oedema. "The ventral surface of mature birds is at all times free of down feathers," (p. 163). It is easier to induce care of chicks than incubation of eggs.

"Care of young can often be easily induced without hormone treatment both in birds and mammals." "Parental behaviour is very greatly dependent on the stimulus situation," (p. 168).

The paper constantly refers to life history studies. The author points out many problems that need further research and she warns against concluding that what has been found true for one species is necessarily true for others. This article furnishes some 200 references.—M. M. Nice.

28. Field Studies on the Behaviour of Sea-Ducklings. P. M. Driver. 1960. *Arctic, Journal of the Arctic Institute of North America*, **13**(3): 201-203. Intensive study of Eider *(Somateria mollissima)* ducklings from before hatching, based on observations in the field in the Belcher Islands, Hudson Bay, of 12 ducklings imprinted on himself and checked by observations on wild ducklings. Six notes are described, the first two starting before hatching: *brooding* note used when the duckling is being brooded by its mother, and *complaint* note uttered when it is uncomfortable. The *cohesion* call keeps the ducklings together; the *contentment* note signifies satisfaction from food or warmth. The *distress* note is given when danger threatens and is followed by a crash dive. The investigatory note is uttered when the duckling is puzzled by the sight of strange objects. The development of feeding and diving behavior is traced briefly. This article is a preliminary note to the full report on these important studies to be published later.—M. M. Nice.

29. Behavior Studies on the Bluethroat. (Verhaltens-studien am Blaukehlchen *(Luscinia s. svecica).)* Valto A. Peipnonen. 1960. *Ornis Fennica*, **37**(3): 69-83. Observations on the Red-spotted Bluethroat in Finnish Lapland during five seasons. Comparisons throughout the paper are made with Lack's exhaustive studies (1939, 1953) on the European Robin *(Erithacus rubecula)*. In the latter species the sexes are alike and both are aggressive, but the female Bluethroat lacks the bright breast markings of the male and she also lacks his aggressiveness. Male Bluethroats reacted with intimidation displays to mounted males and females (as they do to live members of their species), but females paid no attention to the dummies. Male Bluethroats, like male Robins, reacted strongly to the mounted head and breast of a male of their species. Nine sketches from photographs illustrate this interesting paper.—M. M. Nice.

30. Notes on the Behaviour of Whiskered Terns. J. J. Swift. 1960. *British Birds*, **53**(1): 559-572. Observations on some 150 pairs of *Chlidonias hybrida* nesting in the Camargue, France, largely to compare the behavior of this species with that of the Black Tern *(C. niger)*, studied by Baggerman, Baerends, Heikens and Mook (1916) in Holland. In the colony as a whole there was little synchronization of breeding, but within groups there was close correspondance of laying and hatching dates. Behavior of the two species was found to be very similar. In some areas they are sympatric and at times form mixed colonies; they seem to be kept apart by differences in appearance and in voice.—M. M. Nice.

31. Foot-movements in Plovers and Other Birds. K. E. L. Simmons. 1961. *British Birds*, **54**(1): 34-39. "Foot-trembling" and other movements in plovers are discussed as well as "foot-paddling" and other movements in other birds. As to the function of these various movements, the author concludes it probably lies in causing "worms of all types merely to move, and thus reveal themselves or the site of their burrows."—M. M. Nice.

32. Starling Feeds Nestling Robins. William L. Putnam. 1961. *Canadian Field-Naturalist*, **75**(1): 52-53. A pair of *Sturnus vulgaris* that had repeatedly lost their nests built on a downspout on a building were seen about August 17 feeding young *Turdus migratorius* in a nest about 20 feet from the downspout. No adult Robins were noticed then or later about the nest. On August 24 one nestling was found dead on the ground; the next day the other left. All that day it called incessantly from a tree about 100 feet from the nest, while the Starlings stayed around their territory, completely ignoring their foster child. It must have perished during the night. The author concludes that the food

call of the fledgling Robin is so different from that of the fledgling Starling that it "did not release the parental drive of the fosterer after the fledgling had left the nest." We often read of birds feeding young of other species in the nest, but seldom, except with brood parasites, hear of their subsequent fate.—M. M. Nice.

PARASITES AND DISEASES

(See nos. 15, 16)

ZOOGEOGRAPHY

33. The Little Ringed Plover in Great Britain during 1957-59. E. R. Parrinder. 1960. *British Birds*, **53**(12): 545-553. *Charadrius dubius* first nested in Great Britain in 1938. In 1959 nearly 100 pairs bred in a total of 24 counties.—M. M. Nice.

34. Four Invasions of Waxwings during 1956-60. R. K. Cornwallis. 1961. *British Birds*, **54**(1): 1-30. Bohemian Waxwings *(Bombycilla garrulus)* from northwestern Europe invaded Great Britain four seasons in succession. The chief winter food of this species consists of the berries of rowan or European mountain ash *(Sorbus aucuparia)* and the crop of these berries varies widely from year to year. The invasion type of migration is an adaptation to irregularity in food supply.—M. M. Nice.

35. On the Spotted Eagle and its occurrence in Sweden. (Aspekter på större skrikörnen *(Aquila clanga)* och dess förekomst i Sverige.) Gunnar Markgren and Martin Markgren. 1960. *Vår Fågelvärld*, **19**: 273-285. (English summary.) This is a clear and graphic report on the status of this eagle in Sweden. The bird is frequently noted in migration at Falsterbo and in the province of Scania. The rest of the records, 18 in all, are scattered over Sweden, with 50 percent concentrated in the northeastern corner of Norrland. About half are summer records. The rest, except one in May, are fall observations. Nesting was suspected by two summering pairs but not proved. In Finland across the Gulf of Bothnia the species is known to have nested.—Louise de K. Lawrence.

36. New breeding locality of the Murre in Sweden. (Ny häckningslokal för sillgrissla *(Uria aalge)* i Sverige.) Sten Regnell. 1960. *Vår Fågelvärld*, **19**: 285-291. (English summary.) In 1955 the islands of Källskären off the Baltic coast in central Sweden became protected by the State Conservation Authority with landing prohibition extending from 1 April to 15 July each year. The Murre has notably increased since then. In 1960 six breeding pairs were found on one island with eggs and young. This led to the correct identification of a downy young bird (previously mistaken for a Black Guillemot *(Uria grylle)* by Jonsell, VF 1959:97-128) and thus establishing breeding by the species from as early as 1957. Excellent drawings by the author depict nest-sites, eggs, and young. Four nests were found together under a leaning rock and the others in the open amid a colony of Razor-billed Auks *(Alca torda)*. At an adjacent islet, during two successive breeding seasons, a lone Murre was observed flying, always together with a Razor-bill.—Louise de K. Lawrence.

37. Bird observations in the Kalix region 1959. (Fågelobservationer i Kalix-trakten 1959.) Stig Lundberg. 1960. *Vår Fågelvärld*, **19**: 316-325. (English summary.) Observations on 15 species in this far northern part of the Gulf of Bothnia's coastland are given in this paper. Many birds were banded. Three interesting recoveries of Waxwings *(Bombycilla garrulus)* were obtained, two from Scotland and one from Russia. One of the Scottish recoveries indicated a flight by the shortest route of about 1,800 km., 500 km. of these across the North Sea, or an average of about 50 km. a day. The bird that flew southeast across most of European Russia was banded a week after the other two and accomplished the journey in 40 days. In three species first breeding records for the region were obtained, the Smew *(Mergus albellus)*, the Great Grey Shrike *(Lanius excubitor)*, and the Red-necked Phalarope *(Phalaropus lobatus)*.—Louise de K. Lawrence.

38. Red-breasted Flycatcher breeding in Scania. (Liten flugsnappare *(Muscicapa parva)* funnen häckande i Skåne.) Gustav Rudebeck. 1960. *Vår Fågelvärld*, **19:** 325-328. (English summary.) A yearly breeder since 1944 on the Baltic island of Öland, this species has now also been found nesting on the Swedish mainland. The nest was built half exposed in a crotch of a beech. This constitutes a northwesterly extension of the bird's range.—Louise de K. Lawrence.

BOOKS AND MONOGRAPHS

39. The Kirtland's Warbler. Harold Mayfield. 1960. *Bulletin 40, Cranbrook Institute of Science.* Bloomfield Hills, Michigan. 242 pp. $6.00. This attractive book is fittingly dedicated to the memory of Josselyn Van Tyne, who devoted many seasons to the study of *Dendroica kirtlandii.* Mr. Mayfield was closely associated with Dr. Van Tyne in this enterprise from 1944 till 1957 and was given all the material the latter accumulated on this warbler. The monograph covers the history, range, and life history, including mortality and reproduction, as well as a long chapter on the Brown-headed Cowbird *(Molothrus ater).*

Kirtland's Warbler nests only in northern Lower Michigan in young jack pine woods with dry and porous soil; at present considerable suitable territory is not occupied. It winters in the Bahamas. The poplation was high between 1880 and 1900, but has decreased noticeably since then. In 1951 there were less than 1,000 individuals on the nesting grounds. Mr. Mayfield believes the major inimical factor is the cowbird, which is a late arrival in the region and did not become numerous there until the 1890s. About 55 percent of the warbler's nests have been found parasitized. The author calculates that the probability of Kirtland's Warbler eggs producing fledglings "would be increased about 60 percent if there were no cowbird interference," (p. 201).

In addition to the fact of its rarity, Kirtland's Warbler is a delightful bird, handsome, fearless in respect to human beings, and possessed of a fine, distinctive song. It would be a calamity if this especially appealing species were doomed to disappear because of an overpopulation of cowbirds.

The book is clearly written and well organized, with a detailed table of contents, with each subject indicated by a heading, with excellent summaries for each of the 15 chapters, a 23-page bibliography, indices of bird species and of subjects, 6 maps, 12 very good photographs and a charming frontispiece in color by Roger Tory Peterson. I noted only one error—on p. 218, l.37, the co-author of the 1932 paper was L. B. Nice, not W. E. Schantz. Two final pages are devoted to "Problems for Future Study." In my opinion "control of the cowbird in certain chosen areas" seems of paramount importance.—M. M. Nice.

40. The Parasitic Weaverbirds. Herbert Friedmann. 1960. *Smithsonian Institution, United States National Museum,* Bull. **223:** 1-196. $1.00 Brood parasitism has developed twice in the history of weavers, as shown by the Cuckoo Finch *(Anomalospiza imberbis)* related to the ploceine weavers and in viduine species that are related to the estrildines. Brood parasitism is a comparatively new development in the weaver birds, and the similarities in egg color, nestling mouth markings, and nestling plumages in comparison to their usual estrildine hosts can be more logically explained by relationship than by mimetic evolution. "The absence of any structures or habits directly inimical to the young of the host, such as we find in the cuckoos and honey-guides, is an indication of the relative recency of the parasitic mode of breeding in the weavers," (p. 33). The author makes an interesting generalization: "Brood parasitism is merely another way of breeding: It has been established in a number of groups of birds but this fact does not imply that it is a better or more efficient way." (p. 36).

The bulk of the book is devoted to a detailed discussion of all that is known of nine parastitic weavers. The accounts are full of interest and clearly show how much more there is to be learned. This important and authoritative monograph contains four plates in color and 18 in black and white, as well as a 25-page biblography.—M. M. Nice.

NOTES AND NEWS

We note with pleasure the appointment by the Nuttall Ornithological Club of Dr. Oliver L. Austin (Review Editor of *Bird-Banding)* as chairman of the committee to complete A. C. Bent's "Life Histories of North American Birds" series. Dr. Austin succeeds the late Wendell Taber, who had assumed that responsibility upon Mr. Bent's death.

The Golden Press has announced the publication, later in 1961, of *Birds of the World* by Dr. Austin, with 300 color plates from paintings by Arthur Singer. Judging from preliminary proof sheets, both the text and the illustrations will be well received.

The 13th International Ornithological Congress will convene at Cornell University, Ithaca, New York, from June 17 to 24, 1962. This is an honor which comes to any country only once in a generation at most, as the congresses convene only once every four years and meetings are generally in Europe. It affords a magnificent opportunity to hear papers of high quality and to meet ornithologists from all over the world.

For details of the Congress, write to Charles G. Sibley, Secretary General, Fernow Hall, Cornell University, Ithaca, New York U. S. A., as soon as possible. A small fund has been obtained to provide partial support for the travel of a few persons (not citizens of the U. S. or Canada) coming from outside North America; application forms will be sent upon request. Note: applications for places on the program, for travel grants, or to attend the Congress should be returned to Mr. Sibley before December 1, 1961.

A brief index to much of the world literature on field ornithology for the decade 1941-50 can be obtained in the index to *Bird-Banding* for those years. Copies may be obtained from Mrs. J. R. Downs, So. Londonderry, Vermont, at $3.00 (paperbound) or $4.50 hard covers to present NEBBA members or *Bird-Banding* subscribers; or $4.00 (paperbound) or $5.50 (hard covers) to others. These prices include postage.

For the prices and other details of the five types of mist nets stocked by the Northeastern Bird-Banding Association, write to Mr. E. A. Bergstrom, 37 Old Brook Road, West Hartford 17, Conn. We try to maintain stocks adequate for immediate delivery, but it may be wise to order a little while before the nets are actually needed.

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